SCIENTIFIC AMERICAN

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WATT'S ENGINE, A MODERN TURBINE, AND AN ENGINE OF FORTY YEARS AGO.—[See page 206]

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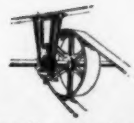

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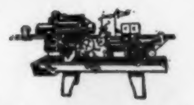

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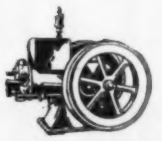

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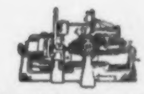

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SEVENTY-FIFTH YEAR

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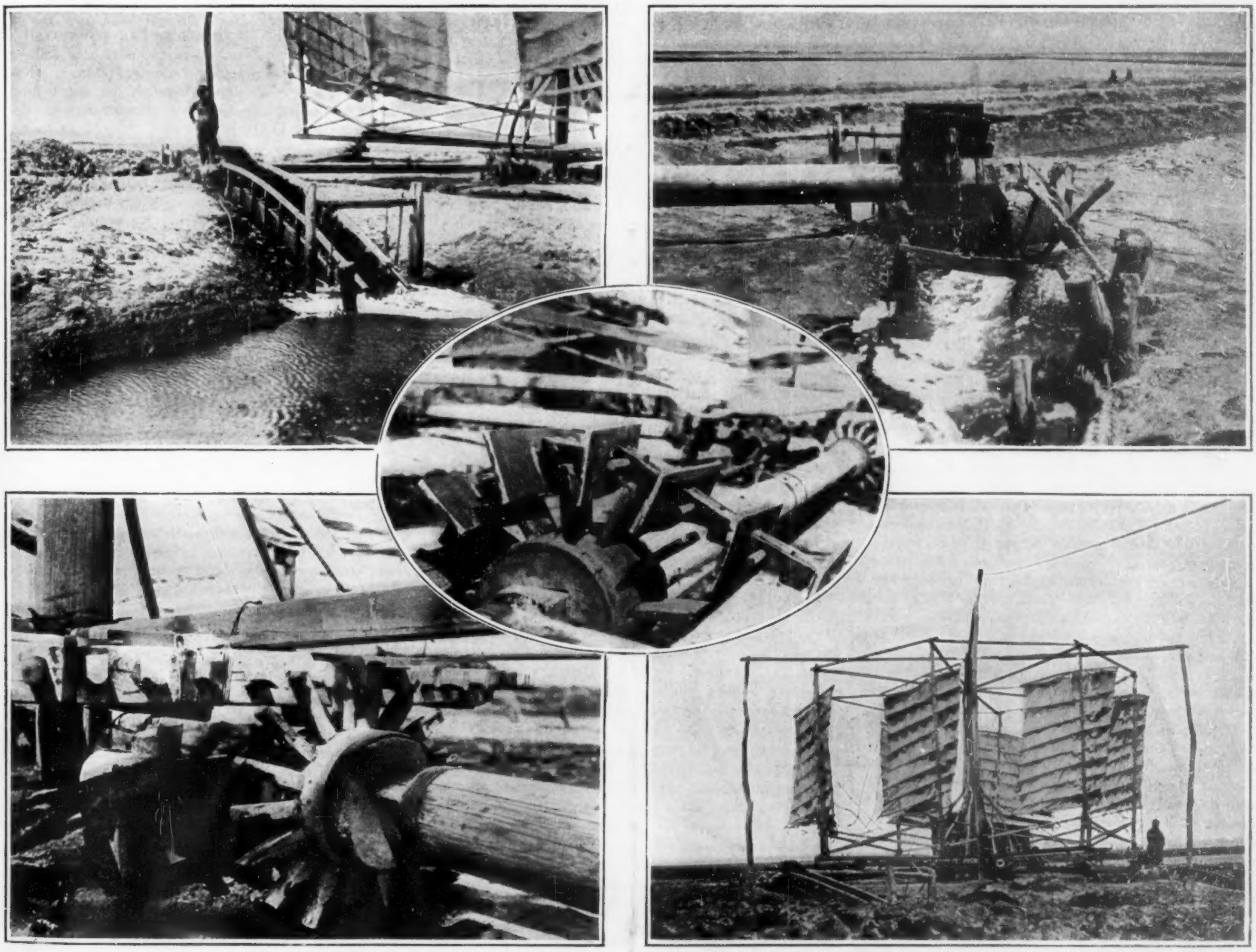

Modern engineering ideas expressed in wood by the remarkable Chinese mechanic

Chinese wind-mill of a high order of ingenuity. *Above:* the intake and the discharge. *Below:* the wooden center gearing and the ingenious sails that tack automatically so as to take the wind at all parts of their revolution. *In the center:* a detail showing the remarkable link-belt that carries the paddles.

Modern Machine Design in Old China

EXCELLENT confirmation of the good old saw to the effect that there is nothing new under the sun comes to us from the Far East, in the shape of five photographs taken by U. S. Trade Commissioner Paul P. Whitham in the interior of China. Mr. Whitham was attracted by a windmill which seemed rather more elaborate in its mechanics than one might fairly expect to meet in such a place, and with the proud consent of the owner and operator, a typical Chinese, he inspected it more closely and snapped his camera at it.

There was nothing extraordinary about the sails; they were in fact of the type so commonly seen on the Chinese boats. It is, however, of interest to note that they are so mounted as to flop over, or tack, automatically twice during each revolution. In this way, though they are true sails and not vanes or fans, they deliver uninterrupted motion to the mill.

The real mechanical genius of the builder of this mill begins to make itself manifest when we examine the intake and discharge. We see then that the link-belt principle, by no means any too familiar to occidental mechanics, has been put to good use here by the "ignorant" heathen. The set of paddles turning on the endless link-belt which are here displayed would do credit to anybody, so far as conception is concerned; and even when it comes to execution, the best use seems to have been made of the available materials. The discharge shows that a very decent volume of water is handled by the outfit. All gears and other moving parts are of wood, but in spite of this they seem to make excellent contact and to be of moderately high mechanical efficiency. It is not known just how long the principle of the link-belt has been known in China; but Mr. Whitham assures us that this mill is a good old one, not copied from any modern occidental machinery, and that to his best judgment it represents the local practice of centuries, if not even of thousands of years.

It stands to reason that China should have preceded the western world in the development of silks and porcelains; this is a matter of raw materials. We can even read without shock that she had the first paper money. But to be told that she probably anticipated our civilization in the invention of important mechanical devices seems to be altogether "rubbing it in."

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Ventilation of the Vehicular Tunnel

IN the course of a recent interview, Mr. Clifford M. Holland, the chief engineer of the vehicular tunnel which is to be built between Manhattan and Jersey City, informed us that he was incorrectly quoted as stating that "the question of ventilation that has given rise to so much debate is a negligible quantity." This statement, which appeared in the weekly bulletin of one of the leading commercial bodies of this city, formed the basis of an editorial in our issue of August 2nd, in which we expressed the conviction that the question of ventilation was of paramount importance, since upon its satisfactory solution the whole success of this great enterprise depends.

We are glad to take this opportunity of stating that Mr. Holland regards the proposed tunnel as being in a class by itself and calling for what he designates as "distinctly pioneer work" both in the preliminary investigation of the problem and in the design of the tunnel itself. Although he has specialized in tunnel construction, and for some years past has been in immediate charge of some of the most difficult work of this character beneath the East River, he realizes that the design, construction and operation of a tunnel some 10,000 feet in length, which will have to carry a heavy automobile and motor-truck traffic, is a very different proposition from that of designing an electrically-operated tunnel, which is entirely free from the poisonous gases that are inseparable from gas-engined vehicles.

At the present time, and as an indispensable preliminary to the consideration of the question of what type of construction or method of driving the tunnel be adopted, Mr. Holland is engaged in gathering all available data as to the density of traffic and methods of dealing with the vitiated air in existing tunnels that are used by automobile and motor-truck traffic, such as the two beneath the Thames at London. The leading automobile manufacturers are being asked to contribute such data as they may possess as to the composition of the gases of the exhaust, and extensive laboratory tests will be carried on so as to afford a basis upon which the capacity of the ventilating ducts may be determined with scientific certainty.

"You can say for me," said Mr. Holland "that once the traffic capacity of the tunnel has been determined, the dominating factor which will determine the cross-section will be the area required for adequate ventilation. The provisions for ventilation, moreover, will include a liberal margin of safety."

This is all as it should be, and we take this opportunity of stating that the SCIENTIFIC AMERICAN is heartily in favor of this great and greatly-needed project. Our criticisms have been inspired solely by the fear lest the magnitude and novelty of the problem of ventilation should not be fully appreciated.

The Future of the Submarine

AT the very outset of any discussion of the future of the submarine we are confronted with the fact that, when the armistice was signed, it looked as though there might be no future for this type of warship; for there was a widespread demand for its abolition even from its legitimate field of warfare on the high seas. This movement was not confined to any one place or people, nor was it merely the expression of uninstructed lay prejudice. Here and there Naval officers were not wanting to join in the outcry against a weapon which the enemy had diverted from its legitimate field, and used as an instrument of piracy and murder upon a vast scale and with pitiless cruelty.

The outcry against the submarine was natural and inevitable. Week by week the toll of merchant shipping sunk without warning had appeared in the daily press, and the public knew full well that behind these cold statistics was being enacted a frightful tragedy of suffering and death. The very name U-boat had become the synonym for utter lawlessness, calculated cruelty and deliberate murder, and it was to be expected that the horror of the thing should express itself in a demand that the military submarine should be put under the ban and its construction forbidden.

Another influence that worked in the same direction was the belief (rather widespread before the war) that the submarine, as a legitimate weapon, had failed to reach a degree of efficiency which warranted the cost of its construction, maintenance and manning. It was claimed that its limitations in respect of speed and vision were so severe that it could not hope to do sufficient damage to the enemy to justify its existence. Before the war the surface speed was seldom over fourteen knots and the speed submerged from eight to ten knots; whereas battleship speed was from 21 to 23 knots, cruiser speed from 25 to 30 knots and destroyers were making 35 knots. The necessity for remaining submerged when within torpedo-attacking range of the enemy, if the enemy were duly alert, rendered the submarine practically "blind" at the very time when good vision was of prime importance.

The demand for placing a ban upon the submarine was, therefore, primarily based upon humanitarian grounds and to a less extent upon technical considerations. The argument was this: Here is a device the degree of whose efficiency as a weapon for attack upon war vessels is a subject of some debate among the navel experts themselves. It failed to drive the enemy warships from the high seas; it failed to break a blockade which was choking the world's greatest military power by slow strangulation. As the last resource of a despairing people it had failed utterly. On the other hand, we have seen that in the hands of an unscrupulous enemy, the submarine can become one of the most frightful instruments of outlawry the world has ever seen. Therefore, so the argument ran, if as a military weapon the submarine has failed to measure up to expectations, and as an instrument of piracy it has proved to be disastrously efficient, considerations of prudence and humanity demand that a ban be put upon its future construction.

There can be no denying that the proposal to prohibit submarine construction has met with strong opposition from naval officers, both in our own and in foreign navies—notably our own and the British—and it is significant that their wish to retain this type in our fleets is due to the fine record which they claim the submarine has made for itself in the late war. It is only since the signing of the armistice that the facts as to the good work of the submarine (we are speaking now of legitimate work against warships, transports and supply ships) have begun to be known. Indeed information only of a very general kind has reached the public; but we are given to understand that the operations of the allied submarines against the enemy were successful beyond anything that was hoped for, even by the Allies themselves. We shall hope to give some general facts as to this good work in a later issue.

The argument in favor of retaining the submarine, as presented by the officers who served in it during the war, points also to the great difficulty of carrying out the provisions, if it should be attempted to enforce submarine prohibition. The submarine they say lends itself to quantity production, and the various parts: engines, navigating instruments, and general equipment could be made at many widely-distributed shops throughout the country. The maintenance of a force adequate to the task of detecting such infringements of a prohibitory law would be, we are told, practically impossible.

We grant that this may be true of the parts and general equipment of a submarine, but we fail to see how it would be possible to build a submarine hull of from 800 to 1,500 tons displacement, without its peculiar model and the characteristic elaborate internal subdivision making its character clear even to the casual passer-by.

But an argument whose validity must be admitted is that which places the submarine in the same category as the airplane and the dirigible, both of which were used unlawfully by the enemy against noncombatant civilians. If you abolish the submarine on the ground of its abuse by the same token we are told you must set a ban upon all craft that navigate the air.

The Lives of Engineers and Inventors

IN connection with the memorial sketch of James Watt, which appears on another page in this issue of the SCIENTIFIC AMERICAN, we are led to recall a wholesome custom of one or more generations ago which we are afraid has been allowed to lapse. At one time it was not infrequent for lads of mechanical tastes to receive as presents from parents or others interested in their welfare that interesting series known as "The Lives of the Engineers," written by Samuel Smiles, an English author of considerable versatility and vogue.

The biographies of Watt, George and Robert Stephenson, John Smeaton, John Rennie, Thomas Telford, and other engineers, had an attraction for an earlier generation, which is readily explained when it is considered how much British industry and civilization, and indeed that of all Europe and America, owed to the men who invented the steam engine, the locomotive, the steamboat; who built such structures as the Thames Bridge, the Eddystone Lighthouse and the Caledonian Canal.

The record of the lives of these rugged British worthies is directly inspiring and helpful, and while such books may be out of fashion today, we are convinced that their perusal would be of incalculable value to many a youth entering on manhood. The story of perseverance, genius, industry and integrity, is one that is compelling in its interest, and while the world and its conditions may have changed, humanity remains indeed the same. Though mechanical problems may be new and the tools different, more complex and more highly developed than those of Watt and Stephenson, yet the solutions are to be found in the same clear thought, singleness of purpose, intense application, trained mind and hands, and study of the men and accomplishments of the past, that characterized these early engineers and inventors.

For the more modern engineers, unfortunately, there have appeared few biographers who have been able to write with such interest and facility as Samuel Smiles, or command his audiences; but in the modern attempt to emphasize the cultural side of engineering the study of the lives of men of creative genius is no less helpful than the mere consideration of their works. Although the materials of their constructions may rust and crumble, yet the spirit of such men never dies. Leonardo da Vinci as an inventor, architect and engineer, was no less an influence than as a painter, while Washington the surveyor and mill builder is no less an actuality than Washington the soldier and statesman. Is not the general public far too prone to look upon inventors, engineers and scientists as eccentric geniuses, and, while recognizing their usefulness, consider as typical men of unusual and picturesque attributes rather than those who have led well disciplined, studious and efficient lives? Would not a more general reading of the biographies of men who have established vast industries through mechanical inventions and vast works of construction be of the greatest value to a rising generation, and would not the lives of many modern workers in applied science be for the sympathetic biographer a profitable and congenial field, that far too long has remained untilled? May not the SCIENTIFIC AMERICAN bring to the attention of its readers the importance of reading such biography, and bespeak in particular a more careful consideration of the lives of the great inventors and engineers?

Electricity

British Telephone Wires to be Underground.—The general scheme planned before the war of placing underground all the wires acquired by the National Telephone Company in 1912, has, according to the London *Times*, been put in hand, starting with Leeds (England) district, plans also having been made and contracts placed for many other big centers. The greater part of the Leeds cable will be laid underground before the end of this year, and it is estimated that the whole program will take between two and three years to complete. The first important underground cable to be commenced was the one between Leeds and London, but will not be the first to be completed.

A New Source of Ultra-Violet Radiation.—A new source of ultra-violet radiation is reported in the *Schweizerische Elektrotechnische Zeitschrift*. The device involves the use of an alternating current discharge at 50,000 volts between aluminum electrodes 2 mm. apart, and situated under water. It appears that the nature of the water is important to secure the best results. Distilled water should be used and kept running. The ultra-violet spectrum thus produced is said to be continuous, and it has proved of great value in obtaining more complete data on certain absorption spectra. In some cases a number of additional bands have been located.

Fatigue Effect of Selenium Cells.—Some further particulars of the "fatigue effect" in selenium cells are given by Dr. P. Lenard in the *Elektrotechnische Zeitschrift*. Such cells have promising qualities as applianes for measuring light, but hitherto certain difficulties have prevented their general application. Among these may be mentioned the "fatigue" that sets in after exposure to light, which results in a progressive change of resistance, cells in the past having been found to be very erratic in this respect. According to the author this difficulty has been largely overcome in the latest forms of cells. Some of these apparently reached a constant resistance after an exposure of only 45 seconds.

French Water-Power Developments.—The *Echo de Paris* in a recent issue states that the necessity of purchasing foreign coal might be relieved by developing the water power of France, which is estimated at 10,000,000 horse-power as compared with 7,000,000 horse-power for Norway and 6,000,000 horse-power for Sweden. Before the war only about 750,000 horse-power was used, but a further 450,000 horse-power was developed during the war, and by the end of 1921, 1,600,000 horse-power, or 16 per cent of France's resources will be worked. This leaves a huge amount of water power in reserve and, in addition, there are large potential resources in the rivers of Indo-China and French West Africa. One million horse-power would lessen the consumption of coal for power production by at least 3,250,000 tons, costing about 300,000,000 francs, and the comparison is more striking when the greater efficiency of the hydroelectric installation is considered.

Government Wireless Station.—According to the U. S. Bureau of Census, it is learned that the Government has erected wireless plants at various points along the Atlantic and Pacific coasts and at Pearl Harbor, Hawaii, and Cavite, in the Philippines. The Government shore stations, according to the reports of the Bureau of Navigation, numbered 135 on June 30th, 1918, of which 88 were in continental United States, 20 in Alaska 19 in the Philippines, 3 in the Canal Zone, 2 in Hawaii and 1 each in Porto Rico, Guam, and Samoa. The Government ship stations totaled 470. The station at Arlington, Va., has been in regular communication with the station at Chollas Heights, near San Diego Cal., since May 1st, 1917. Direct communication with an Italian government station in Rome was also established. On September 29th, 1917, radio communication was established between Arlington and Pearl Harbor, Hawaii, via Sayville, N. Y. Messages are now transmitted between Arlington and the Philippines through San Diego, Cal., and Pearl Harbor, Hawaii. Under favorable conditions, at night, the Arlington station can communicate directly with the Pearl Harbor station, but the usual practice is to relay through San Diego.

Science

American Storax.—The U. S. Forest Products Laboratory at Madison, Wis., reports that during the war, owing to a shortage of oriental storax, which is obtained from the *Liquidambar orientalis*, growing in Asia Minor, this product has been replaced to a considerable extent by a storax made from the American sweet gum (*Liquidambar styraciflua*). American storax has sold as high as $3 a pound. Storax is used in the manufacture of perfumes, tobacco, adhesives and pharmaceutical preparations.

Earthquake Damages an Italian Observatory.—It is reported that the Observatorio Ximeniano, at Florence, which is conducted by the Piarists under the direction of Rev. G. Alfani, was greatly damaged by the earthquake of June 29th. This earthquake destroyed nine villages in the Mugello Valley, near Florence, including Vicchio, which appears to have been the center of the disturbance. The Mugello Valley is a well-marked seismic zone, though the earthquakes here have occurred at long intervals. The recent quake was severely felt at Florence, Bologna, Pistoia, Pisa and Pontedera.

Medical Education in China.—The China Medical Board of the Rockefeller Foundation will soon have in operation in Peking a splendid instituion for medical research and teaching—the Peking Union Medical College. A group of 15 buildings is in course of construction. On account of their green-tiled roofs the new buildings have already acquired the name of "the Green City." The college will open in the autumn of 1919. A preparatory school was opened two years ago. It is expected that the whole establishment, including a new hospital, will be running by the end of 1920. The Board plans to open another medical institution in Shanghai.

To Develop British Mineral Resources.—An Imperial Mineral Resources Bureau has been established in London, charged with the duties of collecting information regarding the mineral resources and metal requirements of the British Empire and of giving advice to the government authorities in reference to the same. The Bureau is to be directed by a board of governors, comprising one appointed by the Home Government, who will serve as chairman, one by each of the five self-governing dominions, one each by the government of India and the secretary of state for the colonies, and six representatives of the mineral, mining and metal industries.

The Second British Scientific Products Exhibition, promoted by the British Science Guild, was opened by the Marquis of Crewe on July 3d at the Central Hall, Westminster, in the presence of a representative company of scientific and technical workers. While last year's exhibit gave prominence to industries engaged in supplying war needs, the present one illustrated the triumph of British industries in the arts of peace. The exhibits were arranged in 11 sections; viz., Mechanical Science, Physics, Textiles, Electrical Appliances, Medicine and Surgery, Paper and Illustration, Agriculture, Chemistry, Aircraft, Fuels, and Metallurgy. The exhibition included various displays of cinematograph films of scientific and technical interest and lectures by leading authorities.

A New Explanation of the "Painter."—Mariners who frequent the coast of Peru are familiar with a curious phenomenon that occasionally prevails there—notably in the harbor of Callao—commonly known as the "painter." The water becomes discolored and emits a nauseous smell, apparently due to sulfuretted hydrogen. The white paint of vessels becomes coated with a chocolate-colored slime; especially when the wet fog known as the garua prevails at the time. Presumably both the discoloration and the smell are due to the decomposition of marine organisms. In a paper recently presented to the Geographical Society of Lima, Senor J. A. de Lavalle y Garcia discusses this phenomenon (which he calls "aguaje") and concludes that the primary cause is the seasonal shift of ocean currents. The "painter" prevails during the months December to April, at which time the warm equatorial countercurrent displaces the cool Peruvian current. The resulting change in temperature of the ocean water would, he thinks, kill quantities of plankton, and the decay of this organic matter would give rise to the phenomena observed.

Aeronautical

Weather Bureau Service for Airmen.—Civilian aviators contemplating long cross-country flights in any part of the United States may now wire Washington to find out what sort of weather they are likely to encounter, according to an announcement recently made by the Director of Air Service. This action is one of the first which implies recognition of the great part aviation is to play in the commerce of the future.

Air Service in the Orient.—According to our British contemporary, *Flight*, the French Chamber will vote additional credits for the establishment of an Aviation Mission in Turkey, entrusted with the organization of the following postal lines: Constantinople, Smyrna, Grecian Archipelago; Constantinople, Palestine, Messa, Egypt; Constantinople, Armenia, Caucasus, Persia; Constantinople, Salonika, the Balkans. It is stated that these lines will be carried on by the military until French air navigation companies have been floated.

Another Arctic Exploration by Airplane.—According to the *Weser Zeitung* of July 2nd last, Dr. Armo Relizi of Danzig and Dr. Walter Geister, intend to start on an Arctic expedition by airplanes. The purpose of the expedition is to make topographical, oceanographical and meteorological surveys, and to test the value of aircraft in the Far North. The expedition will start from a vessel going as far north as possible, which will serve as the base for the operations which will be conducted north of the 58th degree of latitude. The machines will be biplanes of two types: light scouts of great speed, and heavy machines for the expedition proper. They will be fitted with floats with flat bottoms to enable them to land on water and on ice.

A New Magnesium Alloy.—A metal lighter than any yet known, and as strong as or stronger than steel, has for years been the dream of many, and every now and then rumors are circulated to the effect that at last it has been discovered. The advantages which such a metal would have, especially for aircraft, are obvious, but unfortunately it is generally found on investigation that there is a "snag" somewhere. The latest report to be circulated relates to a new magnesium alloy, said to have been discovered by a metal company of Montreal Canada. The new alloy, it is stated, is only two-thirds the weight of aluminum and is "as strong as steel." It is said to be especially suitable for pistons and connecting rods of aero and motor car engines. It is to be hoped that some of the qualities attributed to the new alloy may, on closer examination, be substantiated.

Significance of Oxygen in Balloon Gas.—A perfectly gastight fabric has not yet been realized in practice. Permeability to gases is an intrinsic property of rubber and can only be modified, not eliminated, by the method of manufacture of rubber coatings. The best of the modern airship fabrics seldom have a permeability of less than eight liters per square meter per 24 hours (measured at 25 degrees Centigrade). Thus it comes about that there is always some diffusion of air into, and of hydrogen out of, a balloon, quite apart from the leakage of hydrogen which takes place through holes in the balloon when the pressure inside is greater than the pressure outside, continues *Aviation*. The relative rates of penetration of rubber by hydrogen and air are not the same but are in the ratio of four to one; that is, when the envelope contains approximately pure hydrogen, one volume of air passes through the fabric into the balloon for each four volumes of hydrogen leaking out. But the "air" passing into the balloon is richer in oxygen than normal air, owing to the fact that rubber is about twice as permeable to oxygen as to nitrogen. The method of determining the purity of balloon gas by measuring its oxygen content and assuming that nitrogen is present in the proportion in which it occurs in air is therefore obviously in error. A better method is to determine the specific gravity of the gas in the envelope, when the error in estimating the purity from the result, without actually finding the relative amounts of oxygen and nitrogen in the gas, is very small on account of the small difference in the densities of these gases. The determination of the oxygen content may be useful, however, from another standpoint, that of the determination of the stage at which the balloon gas becomes an explosive mixture. This stage is reached with a greater percentage of pure hydrogen than would be ordinarily the case, since the oxygen content of the "air" diffusing into the balloon is so high.

Completion of the Pearl Harbor Dry Dock

Peculiar Geological Conditions and How They Were Mastered by an Ingenious Method of Construc ion

By A. Russell Bond

THE location of Naval graving docks is usually determined by political and strategic considerations, rather than the geological fitness of the site and the engineer, often finding that the place does not suit the job, must make the job suit the place.

An illustration of this is to be found in the great Pearl Harbor Dry Dock on the Island of Oahu, Hawaii, which has just been brought to completion. The history of its building is a record of baffling problems due to unusual subsoil conditions, which, however, were eventually mastered by an original and very ingenious method of construction. The dry dock is one of the largest in the world, having a length of 1,001 feet in the clear, from the head to the side of the caisson, with a width of 114 feet at the bottom and 138 feet at the top, and a depth of 32½ feet from mean high water to the keel blocks.

When the dry dock was first planned its dimensions were to have been much smaller. It was to have had a length of only 581 feet, with a beam of 195 feet.

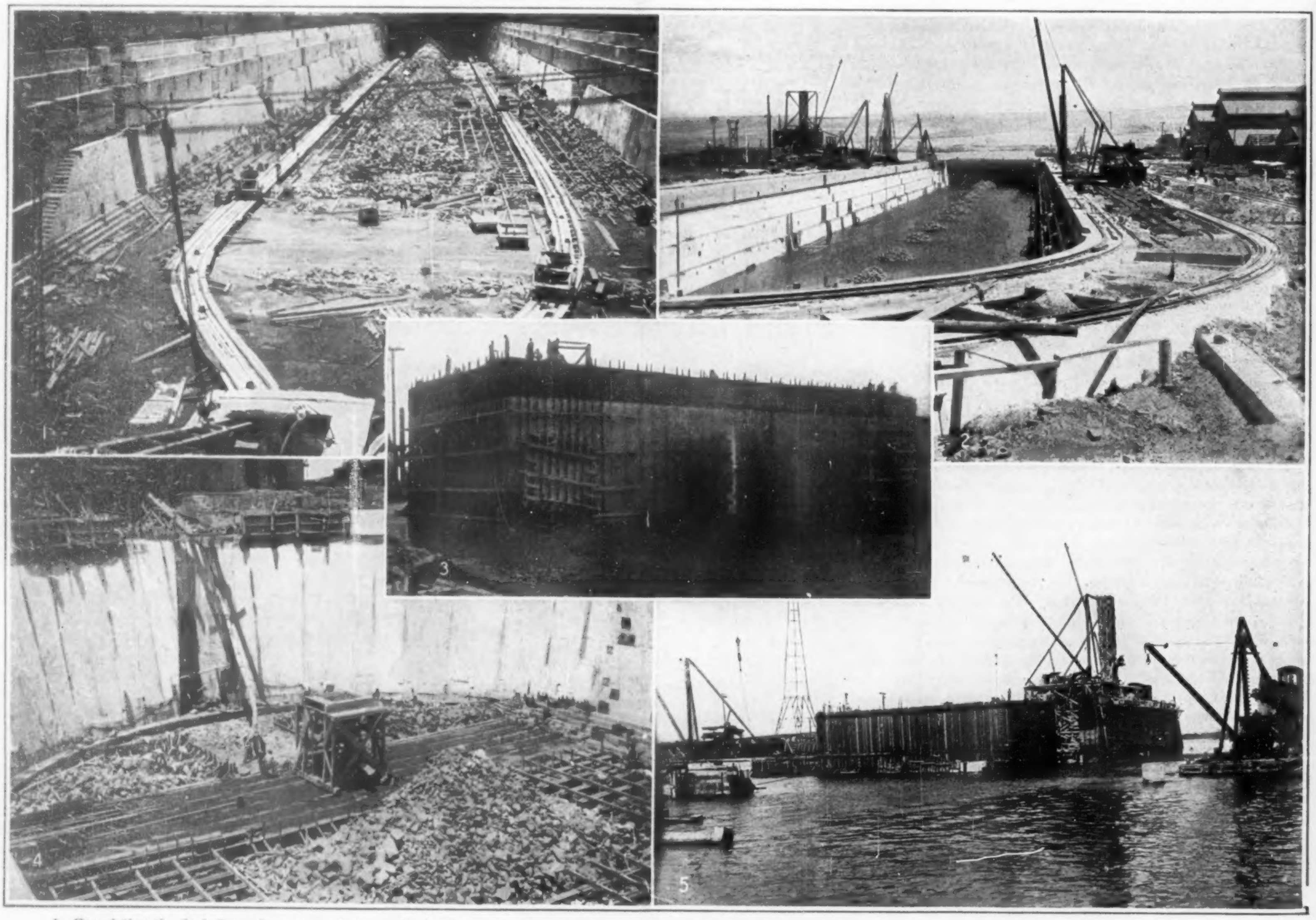
Wash boring at the site of the dock seemed to indicate that the underlying strata were suitable to permit of constructing the dock in the usual open coffer-dam method. The excavation was made with dredges to a depth of from 35 to 38 feet, and the material was loosened by blasting in advance of the dredge. It was assumed that the bottom was impervious to water, and that there would not be any excessive hydrostatic pressure on the under side of the dock. Accordingly a large coffer-dam was built by driving walls of sheet piling into the bed and bracing these side walls with a system of timber trusses.

After one section of this coffer-dam was completed the pumps were started and the operation of unwatering it was begun. But despite repeated efforts it was impossible to lower the water more than 21 feet. The coffer-dam began to show signs of distress. The sheet piling began to rise, showing that there was a considerable head of water to contend with. The unwatering had to be stopped and measures taken to seal the bottom. It was proposed to put down a flooring of concrete under water by means of tremies to a depth of six to eight feet, and in order to hold this concrete in place, piles were previously driven into the bottom with their heads projecting so that when the concrete was poured in they would form an integral part of the floor. This done, the work of unwatering the coffer dam started in Section No. 2 and when it had been unwatered to a depth of nearly 37 feet, exposing some of the concrete, it was observed that the coffer-dam was beginning to rise again. The distress developed rapidly and before anything could be done to check further movement, the entire section collapsed. The mighty hydrostatic pressure burst the concrete bottom, throwing it up and lifting the piles out of the bed. When Section 2 collapsed the sections to either side of it also gave way, and the work which represented more than two years of labor was in the twinkling of an eye turned into a pile of junk.

It was evident then that an entirely different method of procedure would have to be adopted if the dock was to be completed at all. The geological conditions were studied by taking a series of core borings which revealed a peculiar formation.

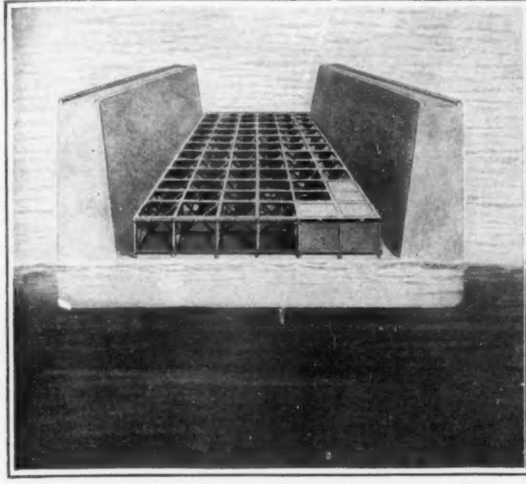
The material of which the bottom was composed had been built up from below by coral polyps and from above by volcanic deposits. There was a confused mixture of coral and volcanic stone, which had been broken up and thoroughly mixed by the ocean waves. In places the material was so hard as to resist the driving of piles, while in other places it was exceedingly soft. There was a layer of clay-like mud, varying from four to forty feet in depth, and while this was to a certain extent impervious to water, apparently the construction work had disturbed it to such an extent that water could pass through it with sufficient freedom to give the full hydrostatic pressure on the bottom of the dry dock.

The problem was studied by a number of engineers and a plan was submitted by the late Alfred Noble, which was further developed by H. R. Stanford, Chief of the Bureau of Yards and Docks, with the assistance of E. R. Gayler, F. R. Harris and L. M. Cox. The plan was a most novel one. The problem was to lay the floor of the dock and hold it down against the full hydrostatic pressure of the water. It would have been impracticable to have made the floor so thick that it would have stayed down of its own weight, and this was not necessary because the side walls resting on the floor would serve as weights to hold it down, pro-

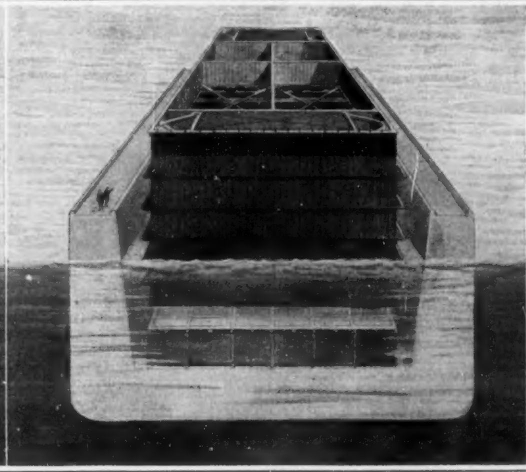


1. Completing the dock floor after unwatering. 2. Rock-piles on the floor of the dock to hold the structure down while it was being unwatered. 3. The coffer-dam-boat with side gates raised to permit of removing it from a finished section. 4. Pouring concrete at the head end of dock. Note the pre-cast wall sections. 5. The pump-well crib over its final location. Note the floating dry dock at the right in which a floor section is being built.

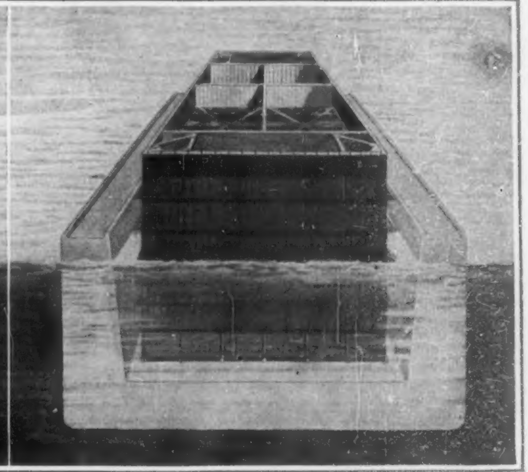
Various stages in the construction of the Pearl Harbor Dry Dock



Steel frame for a floor section of the concrete dry dock being erected on a floating dry dock, and the imbedding concrete partly placed



The floating dry dock lowered to permit of moving the coffer-dam-boat into position over the floor-section



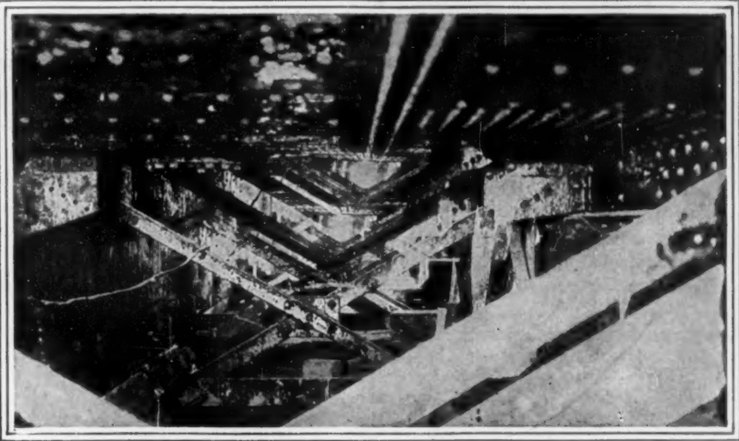
The floating dry dock in its deepest position just before removal of the coffer-dam-boat with its attached floor-section

vided the construction of the floor was such as to prevent it from being burst open in the middle. In other words, the floor had to withstand pressures which were the reverse of those encountered in the floor of an ordinary structure. This called for the use of exceedingly substantial trusses, capable of enduring the tremendous hydrostatic pressure across the entire span of the dock. The new plan was to build the floor in sections on a floating dry dock, and then to use a structure known as a "coffer-dam-boat" to pick the floor section off the floating dry dock, after which it could be towed and lowered to its final position, coffer-dam and all, and while in this position the side walls of the section would be built within the walls of the coffer-dam.

The floor sections of the concrete dry dock were to be 152 feet long and 60 feet wide. In other words, the concrete dry dock was to be made up of sixteen sections of 60 feet each measured along the axis of the dry dock, with a space of three feet at the top and five feet at the bottom of the floor, between each pair of sections, which was to be filled with concrete laid in the wet by means of tremies.

A floating dry dock was first built with a clear space of 76 feet between the side walls and on this the floor sections of the concrete dock were constructed. They consisted of steel trusses spaced ten feet apart and 152 feet long or the extreme width of the graving dock between outer sides. The steel trusses were then filled in with concrete, but in order to reduce weight as far as possible and facilitate handling of the heavy slab, the middle pockets of the floor section were only partially filled.

After a floor section had been prepared the floating dry dock was lowered to permit of towing the coffer-dam-boat over the floor section. This coffer-dam-boat consisted of a huge steel box designed to be made fast to the floor section and was deep enough to reach above water level when the floor section was sunk to its final position. The coffer-dam-boat was sub-divided by means of bulkheads to form water ballast tanks, which would be filled with water to lower the structure with the floor which it was carrying. At each end of the coffer-dam there was formed a compartment which was open at the bottom and within which the side walls were to be built. After the tank had been floated over the floor section, the floating dock was first raised to permit of attaching the coffer-dam-boat to the floor and then it was lowered, to permit of removing the coffer-dam-boat with its floor. Then the coffer-dam-boat was towed to proper position at the site of the dry dock. Here a bed had been prepared for it, carefully leveled off to the required depth, with piles driven into the bed in order to form a firm foundation. Water was pumped into the ballast tanks and the structure was gradually lowered into place. After it was properly seated workmen entered the compartments which opened on the concrete floor section and within these chambers the side walls were built up. When that work had been accomplished the coffer-dam was detached from the floor section, water was pumped out of the ballast tanks and the coffer-dam rose to its highest elevation. In order to clear the side walls which had been built within the coffer-dam it was necessary to provide gates in the coffer-dam-boat at one side which could be removed. One of our photographs clearly shows this, with the gates lifted. This done the coffer-dam could be towed off to the floating dry dock where in the meantime another floor section had been built, and was ready to be deposited in position. Thus the work proceeded step by step.



View of the braces under the ballast tanks of the coffer-dam-boat

At the head of the dry dock the semicircular wall was formed of pre-cast blocks which were lowered upon the floor section that had been set in place by means of the coffer-dam-boat. Keyways were provided for making the wall blocks fast to the floor by means of tremies. After the floor sections had been laid, the spaces between them were filled with concrete by means of tremies and the spaces between the wall sections were filled in by workmen operating within local coffer-dams. As the floor sections were only partly filled with concrete, it was necessary to load the floor with broken rock to keep it down when the dry dock was unwatered. After the dock had been unwatered the floor sections were successively filled with concrete while the stone was removed before the advance of the workers.

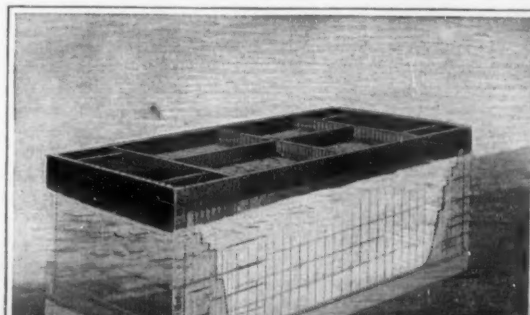
The dock is now completed and is ready for the ships of Admiral Rodman's newly organized Pacific fleet. It will be capable of accommodating the largest vessels now afloat or contemplated. Total appropriations for the project to date have been a little more than $5,000,000.

Sleeping Habits of the Horse

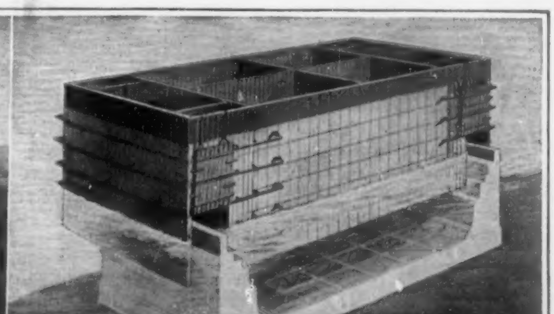
ELEPHANTS have an acute fear of mice, and the mere presence of one in their hay will cause an entire herd to raise their trunks aloft, apparently indicating that they are afraid the small rodent will scamper up the proboscis.

It is sometimes argued, similarly but not by any means conclusively, that horses from the same instinctive fear of mice and insects, rest and sleep largely while standing. Among our domestic animals probably no habit is otherwise so inexplicable. When turned out to pasture, horses are apt to spend more time lying down, but even at that they seldom spend more than one hour a night recumbent. That hour is generally taken at midnight.

It is not uncommon for people to express wonder at the quiet way many horses will stand, practically motionless for hours in one position. Few people realize how complete is the relaxation obtained, and to what extent the horse is able to rest in a few hours of such repose. Stable men not infrequently tell of horses which they confidently declare never have slept, except on their feet, in their lives. The trait is more marked in some horses than in others, but concerning the very short period a day many horses sleep off their feet there can be no question, as in all-night livery stables there has been ample opportunity for continuous observation.



The floor-section lowered to its final position and the side walls being built within the coffer-dam-boat, as indicated by dotted lines



Section of the concrete dry dock completed and coffer-dam-boat being removed. Note the gates at each end opened to clear the walls of the dry dock

When the Compass Goes Crazy

The Peculiar Conditions of Flying Which Make the Needle Misbehave

By C. H. Claudy

> *"............that's why I landed here in a crash, instead of the field forty miles away. The compass just went plain crazy.....turned and twisted and swung this way and that......didn't make any difference how straight I steered or how careful I was of inclination, the compass behaved as if possessed."*
>
> *Thus, bewails some unfortunate airman who has depended too much on his compass and forgotten or failed to learn that a compass in a ship is one thing, and a compass in an airplane quite another.*—THE EDITOR.

WITH transoceanic navigation of the air an accomplished fact, and only time, opportunity and effort standing between civilization and a complete mastery of air travel, not only across the Atlantic but across all the seas and all the continents, everywhere, the compass rises to a position of importance which requires not only the most careful instrument making, but the most elaborate studies to determine what new factors the airplane has brought to this oldest of navigational instruments. Such studies have been undertaken by all nations, but especially by the French, who have worked hard upon them and given to the world the result of their investigations.

A compass, as used in navigation, consists: First, of "the card" or "the rose" as it is called abroad, the circular material bearing the inscriptions of the points of the compass and the degrees, and the several magnets beneath. This is mounted upon some sort of pivot, or supported in a liquid as well as on a pivot. Second, of the bowl which holds the liquid or supports the pivot or both. Mariner's compasses are hung in gimbals to compensate for changes in level due to the action of the sea.

The action of the compass comes from the attraction of that great magnet, the earth, upon the permanent magnets of the card or rose. This action is not, as the working of a compass would seem to indicate, only a horizontal force, but one inclined at an angle towards the vertical. Only the horizontal component of this force is of use by the compass. But if circumstances bring the second or vertical component of the angular-to-the-vertical magnetic force into play, the resulting compass action is anything but a truthful delineation of the facts.

The Capers of the Compass

Certain deviations from fact occur in the action of the compass in a rapidly moving airplane which at first sight seem to indicate that the instrument has "gone mad" or "lost its magnetism." It is, therefore, highly important for the pilot who must at some time depend upon his compass, to know when it is telling the truth and when it is misleading him. Obviously, a properly mounted compass, properly compensated, and not affected by engine vibration, will, when used in a plane flying straight ahead on a level, tell the truth as to direction. But if a plane be flying from south to north and turn suddenly to the right with a steep bank, the needle, instead of remaining pointing towards the magnetic north, *will also turn to the right*. If the aviator trusts his compass here he will be seem to be turning to the left. If a similar turn is made to the left from a south-north direction, the needle will not indicate it, and when the half turn is completed and the aviator is pointing his plane due west, the needle will show him going to the north. If the airplane be caught in an eddy, and be compelled to turn and dodge and twist to balance and keep going, the compass will indicate anything except the true direction.

These peculiar actions are in part due to the motion of the liquid on which the card is partly supported. But the greatest factor in the error is the inertia of the whole instrument, and the consequent inclination of liquid, pivot and rose, due to the centrifugal force exerted when turning at high speeds. Those who have had the experience of flying will recall that no matter how steep the bank on a turn or how far they leaned to right or left, there was never any sensation of falling. Even in a loop there is no physical sensation of being upside down; centrifugal force holds the body firmly in its place. It also holds a compass firmly in its place and maintains the card parallel to the axis of the plane. In a ship, the periodic movement due to wave action is slow and stately, and the instrument is not influenced by any force sufficiently greater than gravity to affect its true level. In an airplane, centrifugal force is of vastly greater effect than gravity and the gimbals simply do not act.

The result is that the needles of the magnet are brought under the influence of the vertical couple of the magnetic force, instead of the horizontal couple alone. Not infrequently under this new influence the needle makes a complete half-turn. The action of the vertical couple may be so violent as to exceed the action of the horizontal couple entirely. It is theoretically possible to fly in a steeply banked circle so that the wings are almost if not quite parallel to a line joining plane to earth. In such a case it would be physically impossible for the compass needle to point to the north, since it would be vertical, under the influence of centrifugal force. Its gyrations then would be those caused by the vertical, not the horizontal, component of the magnetic force of the earth.

Compass Inertia

To obviate such erratic actions of the needle, compasses of very slow period have been tried—that is, those which when disturbed return to their true position over a long period of time, from thirty to forty seconds. It is easy enough to make a long-period compass, since the period of a compass depends upon the strength and number of the magnets, the weight of magnets and card, the friction of pivot and liquid. The heavier the magnets and the card, the less the strength of the magnets and the greater the viscosity of the liquid, the longer will be the period of the compass. Long period compasses do not "swing" easily; they do not vibrate back and forth before coming to rest, but move majestically to the true magnetic north and there stop. Hence it seemed that a slow period compass might solve the difficulty of the mad antics of the instrument in a rapidly moving and swiftly turning plane.

But experiment proved exactly the opposite. In the first place a pilot does not use a compass to tell him when and how to make a turn. It is to him a guide in running a *straight* course from point to point. In eddies, it is not at all axiomatic that any turn leads to an inclination inward; the compass may or may not incline with the plane. There may be a turn which is largely side-slip and in which there is no centrifugal force of any consequence exerted. A very slow-period compass may not have time to swing true in a rapidly moving plane before it again changes direction and inclination, and if such is the case, the pilot will have made two turns without knowing in just what direction (supposing a heavy mist or a fog or cloud to obscure landmarks). In a slow-period compass, if the aviator corrects his direction by the slow swinging needle, he will not know just when to check his turn. If the compass then swings back, the pilot may be unable to tell whether the instrument is oscillating or whether the plane is deviating. Practice has demonstrated that when a plane compass begins to swing in a fog, it is almost impossible for the aviator to stop the swinging by any adjustments of the plane. He gets the impression that his compass is "crazy," believes he is flying steadily and that it is gyrating, loses all indications of his route . . . and lands in a field forty miles from home.

So the short-period compass has been retained. English aviation compasses swing in from nine to eleven seconds, about the minimum possible for the approved form of large card, light rose, and strong, though very light magnets.

How to Mount the Compass

It is essential to place the compass on the plane as far from steel or iron masses as possible, in order to allow for the best possible corrections and to have as little local vibration as may be. Fixed masses can be tolerated close to a compass, but movable masses—such as controls, for instance—should never approach nearer to the compass than half a meter and better, a whole meter.

It is also necessary to consider the matter of vibration. Of course, the entire plane vibrates under the action of even the smoothest-running engine. But the plane is a complicated, not a simple whole, and it has nodes, even as has a wire string, where engine vibration is least. Such a place is the best place for the compass. It is also necessary to observe the compass narrowly under all possible flying variations of engine speed, because at certain speeds the rose will respond with movement, even, at times, with swinging completely around, which movement quite disappears at greater or less engine speeds. It is essential, then, that the pilot know these speeds in order that he may know when he may and when he may not depend on his instrument.

In use, the compass is seldom consulted when landmarks will take its place, save for additional evidence. Hence, flying in clouds, over clouds, over the sea or over totally unfamiliar territory furnishes the times and places where its use is most needed.

The Circumstances of Blind Flying

Flying in clouds means always flying in eddies. The airplane moves too rapidly for any compass to follow. It is, therefore almost axiomatic that the compass should not be trusted in flying in clouds. The aviator gets above or beneath them and steadies his plane before believing his instrument.

Above the clouds, he may steady his plane by observing some cloud formation as a fixed point. Once he gets his plane flying true and level the "crazy" compass will return to sanity and he can then get his direction sufficiently to allow him to make a journey of a hundred kilometers with less than ten per cent error (if he knows anything of his drift). At a height of a mile, an objective ten kilometers from the vertical should be reasonably sure of recognition.

Above-sea flying is not difficult if a cloud or boat or any land-mark anywhere can be consulted for stability of direction. If no such indications are present and especially in fog or mist, the plane will often turn without the pilot knowing it. Hence the compass is valuable in indicating the fact, if not the direction, since such a turn will make it begin to oscillate and swing—"go mad," in other words. Then the pilot must adjust engine speed for least compass vibration, make his turns, hunting a stable point for the compass, as wide, as slow and as level as possible and try to find some visible stationary point, if only a hole in the mist, towards which he can steer long enough to stop the gyrations of the compass.

As a last resort, when no careful manipulation of the plane succeeds in quieting the compass, the aviator may fly low enough to the sea to throw out something, anything, a card, piece of cloth or other object, make a half turn and steer for it, when the compass will immediately become sane again. Flying east or west then with care will keep it sane until better conditions obtain and a landmark be sighted.

Many aviators firmly believe that there are magnetic currents or disturbances in the upper air which affect the compass and make it "go crazy." Long experiments and careful investigation, however, seem to prove conclusively that it is not the compass, but the plane, which goes mad, that it is always the plane which moves distractedly, in the first place, and that the apparent insanity of the compass is due to these movements and the vertical magnetic component of the governing force. The maddest of compasses, the most contradictory and insane of cards, will steady down to a quiet behavior, once the plane is successfully set on a straight and level course for a period of time greater than the period of the compass.

Coronium in Natural Gas?

Messrs. H. P. Cady and H. McK. Elsey, of the University of Kansas report in *Science* that they are developing new spectroscopic equipment and methods for the purpose of definitely settling the question whether certain lines that have been frequently detected in the spectrum of specimens of helium, obtained from natural gas, are due to coronium, as has been suspected. Living and Dewar observed some "wild" lines in specimens of Bath gas which they suggested might belong to the spectrum of coronium. Cady and McFarland found lines corresponding closely in wave-lengths with the lines of coronium in the spectroscopic examination of samples of helium from natural gas.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Another Advantage of the Metric System

To the Editor of the SCIENTIFIC AMERICAN:

The letter of E. S. Mummert in your issue of July 19 opposing the adoption of the metric system overlooks the fact that linear measurement is only a small part of the system. That it is a decimal system is the only advantage conceded by Mr. Mummert. The advantage to be gained by using the metric system is not only that it is a decimal system, or that it will meet the demands of international uniformity, as you point out in your editorial note, but that the metric system establishes a relation between the kilo, the liter, and the meter—the units of weight, of capacity, and of length.

Our clumsy system of weights and measures, with its avoirdupois pound and its troy pound, its long ton and short ton, its scruples, its pennyweights, its Imperial gallon and U. S. gallon, its dry quart and liquid quart, its links and chains, its rods and furlongs, is an inherited tradition from the Dark Ages, not deserving the name of system. "A pint's a pound the world around" is the nearest we come to a relation between weight and capacity, but this is not accurate, and unfortunately our little rhyme does not tell us how many cubic inches are in a pint. On the other hand, the metric system is a scientific system based on correct principles. When we know that one cubic centimeter of water at maximum density (4 degrees Centigrade) weighs one gram, that a kilo is one thousand grams and a liter is one thousand cubic centimeters, and that therefore a liter of water weighs a kilo, we have a system that makes the conversion from measure to weight or to capacity simple. This, to my mind, is the great value of the metric system.

The fact that the chemists of the United States and of England have had to discard all our antiquated systems of weights and measures, and have adopted the metric system and the centigrade thermometer, which is so closely related to it, should prove that sooner or later we will have to come to it in all other branches of science and industry, if we would keep up with the progress of the world.

P. N. HOLST.

Palatka, Fla.

A Crisis for the Metric System

To the Editor of the SCIENTIFIC AMERICAN:

The letter in your issue of July 19th entitled "An Alternative for the Metric System" brings up a subject of great importance. I believe we are nearing a crisis in the battle of weights and measures. A false step now may delay for centuries the realization of a uniform system for the entire world.

The principal scheme advocated by the opponents of the metric system is a decimal system based upon the inch. They advance two main arguments; first that their inch system is more convenient than the metric; second, that it can be more easily introduced.

They claim that the sizes of the meter and its derived units are not so convenient as the sizes of the inch and its multiples; that the centimeter is too small and the meter too large. Now a unit is inconvenient when it is very much greater or smaller than the object which it is used to measure, because it is then necessary to use too many figures in expressing the dimension of the object. For instance, we should find it inconvenient to measure the thickness of a sheet of paper in miles, or the length of the Mississippi in inches. This is why every system contains a series of units of different sizes, so that a unit may be chosen proportionate to the size of the object to be measured. But we commonly use no unit between the pound and the ton, which equals 2,000 pounds; nor between the yard and the mile, which equals 1,760 yards. Therefore any system which contains units separated by multiples of ten, provides more than are needed; all decimal systems are equally convenient, so far as the size of the fundamental unit is concerned. We prefer the sizes of the inch and the foot merely because we are accustomed to their use.

The second argument of the advocates of the inch system is that it can be more easily introduced. On its face, this appears plausible, for would we not retain the inch itself, in accordance with which such a vast amount of machinery has been built? But if we wish to imitate the metric system, the inch is the only unit which we can retain. We should have to discard our measures of capacity, and adopt a unit equal to one cubic inch. We should have to adopt a unit of weight equal to the weight of one cubic inch of water. Then every one of our old weights and measures except the inch would have to be converted into the new units, and this would be as much work as converting to the metric system, with the difference that the metric conversion tables are already prepared, and scientists and engineers have been accustomed to their use for a century. We should have to begin making a vast number of new measuring instruments and weighing machines, with all the difficulties of new manufacture, whereas if we adopted the metric system we should find all these instruments already on the market. I am afraid we should find after we had passed through the throes of introduction, that we had had considerably more trouble than if we had adopted the metric system.

The value of any system depends largely on the number of people who use it. If every man devised his own separate and distinct weights and measures, no doubt a few wise men would have very superior systems, but they would be of little value. The world must adopt a decimal system. Will it be the metric or some other? A century ago it might have been possible for another system to arise and successfully compete with the metric, but it is too late now. The metric system has been with us too long, and is too firmly entrenched ever to be dislodged. The only danger is that the world may be divided between two decimal systems. The best way to avert this is to work energetically to secure at least the partial adoption of the metric system for every-day use. Our customary system is divided into three divisions which have no relation to each other; measures of length, capacity, and weight. If it should be too difficult to change our entire system at one time, then let us adopt the metric weights alone, leaving the other two divisions for the time unchanged.

It is unfortunate that a certain loss to business men is unavoidable during a change of system, and it would be only just if the government indemnified them by buying up their old instruments. The nation as a whole benefits by the change, and it should bear the cost. However, the cost of such a change to manufacturers, I believe, is usually greatly exaggerated.

In the last five years we have had much excitement about foreign trade, but we have not yet taken the fundamental step in obtaining it, namely, the adoption of the metric system. Germany built up in a generation the great foreign trade which she had before the war, and the metric system was a powerful factor in her success. Yet we lazily refuse to accept this wonderful instrument of science, which Nature holds out in the hollow of her hand. The meter whirls while we sleep, counting out the dollars which drop into the pockets of our competitors.

ELLIOT STEWART.

Brooklyn, N. Y.

Decimal System vs. Binary

To the Editor of the SCIENTIFIC AMERICAN:

In the matter of a system of decimal measurements based on the inch as proposed by Mr. Mummert. The system is ingenious, and in my opinion, decidedly preferable to the metric system. Mr. Mummert bases the merit of his scheme on the assumed superiority of the decimal divisions over the binary divisions in common use. He gives the impression several times that this superiority is universally conceded. I wish to oppose this assumption, and say that in my opinion for factory and industrial uses, the superiority rests with the binary system of divisions.

I do not deny the value of decimal measurements for precision dimensions. Micrometers and verniers and machine tools are made to this system and the adaptability of decimal divisions to this purpose is admitted. But there is an immense amount of work laid out and done by scale measurements, and for these uses there is nothing better (yet) than halves and quarters and so on down to 64ths. It is easier both habitually and intrinsically to use a scale, rule, or measuring stick graduated to binary divisions.

The binary scale can be marked in halves, fourths, eighths, 16ths, 32nds, and 64ths, and each series is legible and differentiated from the others. The decimal scale can be marked only in tenths and hundredths. In one system there are six steps of fineness, in the other there are only two. If halves are not fine enough for a particular case, there are fourths; and if that is too coarse, there are eighths, and so on until a suitable degree of refinement is reached. On the other scale there are only tenths and hundredths. If tenths are too coarse, there is nothing for it but hundredths.

The finest graduation on one scale is 64 divisions to the inch; on the other 100 to the inch. On the 64th scale the marks are 56 per cent further apart and 100 per cent more legible. Furthermore, only a small proportion of the dimensions require 64ths. Even 32nds are not used as frequently as the larger divisions. But on a decimal scale the finest divisions (hundredths) are in almost constant use, because only a small proportion of the dimensions can be expressed in tenths, and as before stated, there is no place to stop between tenths and hundredths.

K. KAPETO.

Topeka, Kan.

Carnegie—Executive and Engineer

FOR many years the engineer was merely the man who went out into the uncharted wilderness and laid down the track along which civilization was to follow. He was a pioneer in a double sense. On the one hand he was to be seen pushing forward into the untravelled portions of the material sphere on which we live, laying down railroads, opening up mines, and in general establishing the physical aspects of civilization. On the other side of the picture he stood as the pioneer of thought, doing things which had never been done before, searching out facts which had never been known before, adding something every day to the accumulated store of human knowledge. But he was ever master of his own activities; and the things which he made and found passed immediately out of his hands and into those of the man whose abilities and interests were in the financial field.

When the executive and the administrator were confronted with a decision to be made that involved engineering values, they called in the engineer as from a world apart and bought his expert knowledge. But the engineer and the executive did not possess the same points of view, or the ability to reconcile their divergent impulses. Accordingly decisions were far too often made on grounds of financial expediency alone, with engineering values considered only in so far as they supported the course of action upon which the executive had set his heart from the beginning. The engineer had no appeal from and little influence with the executive.

Within the past few decades this fault has been substantially corrected. More and more we have recognized the absurdity of putting a man in control of production because he is a wizard at selling bonds, or of supposing it possible for an executive to hire and fire men to supervise processes of which he is profoundly ignorant. The gulf between executive and engineer has disappeared. Our executives have become engineers and our engineers have turned executives. The executive who cannot pass sound judgment on a technical problem is today as much out of place as the engineer who cannot handle men. The millionaire manufacturer who, on the witness stand the other day, boasted of his general ignorance and pointed out that he could hire men to tell him anything he needed to know—well, he is an anachronism, in spite of the great success which he represents, in spite of his ability to interpret and apply the engineering judgments thus purchased. Today we don't do business that way.

If we look back over the latter half of the nineteenth century, we will see that it was dominated by a few men who combined the qualities of great executives with those of great engineers. The great steel and coal and packing and transportation industries were created in the first instance by men like Hill, who complained bitterly that he was a better engineer himself than any man whom he could hire to do the work for him; like Harriman and Huntington, who knew every inch of every line of track in which they were interested; like Carnegie, whose death on August 11th almost may be said to have brought an era to a close. For while we still have with us the executive-engineer, the day of the captain of industry has passed. The very fact that the executive-engineer is the order of the day reduces him to a mild commonplace, and insures that outstanding figures like those of the Scotch ironmaster will no longer arise. Such domination as was his is attained by pioneering; and the game which he played so well has gone beyond the pioneer stage.

Carnegie founded the steel industry of the United States when he recognized the inherent superiority of the Bessemer process and imported it into this country. That is the technical achievement on which his fame rests, and which qualifies him to rank among the executives of great engineering vision. For him there was no need to call in a squad of engineers of ordinary stature to advise him how to make steel under the conditions confronting him in western Pennsylvania. He knew how to do this—even down to the necessity for building a railroad to serve his mills, and the best location for that railroad. And then he went ahead and did it, displaying executive capacity fully equal to his engineering ability.

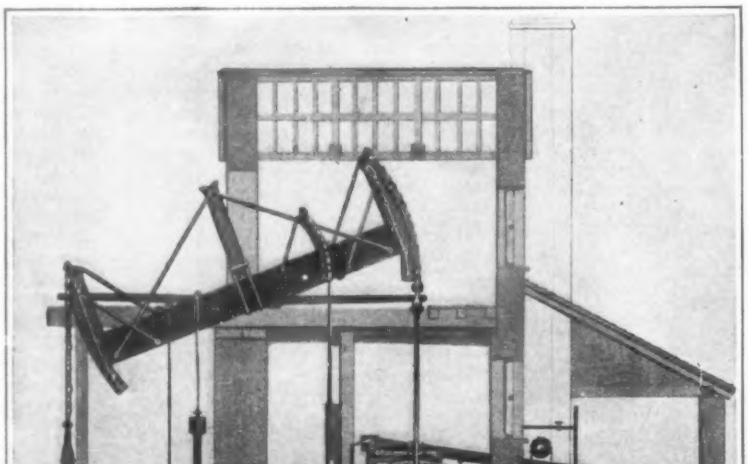
The James Watt Centenary

One-Hundredth Anniversary of the Man Who Made the Steam Engine What It Is

By Herbert T. Wade

ONE hundred years ago, on August 25, 1819, there died at Handsworth, near Birmingham, England, James Watt, to whose genius is due the development of the steam engine on a practical basis that made it generally applicable for power production. This important work unquestionably was the foundation of the great industrial transformation and progress that characterized the nineteenth century, a period in which the influence of mechanical science and industry was quite as compelling as statecraft and politics.

While James Watt made many inventions, yet it is in connection with the steam engine that his title to fame rests, and here three great achievements stand out not only as mechanical triumphs, but for their immediate and lasting effect on the progress and development of civilization. Watt's patent of 1769 improving the Newcomen engine not only laid the foundation for his later work but at once made this machine far more economical and efficient and facilitated the coal mining in which it found chief use. His invention of 1781 whereby it was made possible to use the power of steam rotatively marked the beginning of the use of the steam engine as a prime mover for a wide range of activity, from which resulted the factory system and the modern idea of mass production. Then as a further and natural development came the patent of 1782, in which provision was made for the double-acting steam engine and for using the force of the steam in the cylinder expansively, thus bringing before the world the modern reciprocating steam engine which for over a century held undisputed sway as a source of power. Numerous other inventions, of course, stand to the credit of this great man, in whose life were encountered many of the same problems as confront us today and whose conquest of these was accomplished through sterling character, perseverance, study, industrious experiment, and scientific methods, qualifications quite as available and useful in the twentieth century as in the eighteenth.



Newcomen pumping engine with external condenser as developed by James Watt

James Watt was born at Greenock, Scotland, January 19, 1736, "of humble lineage" according to one biographer; but as we read further that his grandfather was a well-known mathematician and schoolmaster, and his father a carpenter and merchant at times honored by selection as treasurer and chief magistrate of his native town, the average American would consider such forbears as the truest of aristocrats when it came to the production and training of a mechanical genius. Unable through ill health to attend the town schools regularly, Watt received instruction from his parents, learning at the same time the use of tools for wood and metal working. An important element in the development of this well disciplined inventor was that much of his early time was spent in the construction of models and ingenious original mechanisms. Furthermore the taste for reading and mathematical study, also characteristic of the true inventor, developed early and continued throughout a busy life.

With precision of thought and workmanship acquired early, it was quite natural that at the age of eighteen Watt should take up the calling of instrument making, a profession that many scientists today lament no longer appeals to such youth. He worked in Glasgow and London, but the climate of the latter city did not agree with him and he returned to his native town, later moving to Glasgow, where he attempted to open a shop of his own. Prevented in this effort by a labor guild of that day, the Corporation of Hammermen, on the ground that he had not served the requisite apprenticeship, he most fortunately became instrument maker to the University of Glasgow, where he gained the interest and friendship of several noted scientists then members of its faculty. Not only was Watt aided in his studies, but he enjoyed that invaluable contact with theory and research, so appreciated by the so-called practical man and true inventor, many of whom have had good reason to thank the universities and their professors for inspiring co-operation and assistance.

Here in 1764 Watt was called upon to repair the model of the Newcomen engine which is still preserved in the University's collection. This marked his first active attention to steam and its properties, though as early as 1759 at the suggestion of his friend Dr. Robison, Watt had commenced work on a little model of a self-propelled carriage with two steam cylinders and pistons connected to the driving wheels by an intermediate system of gearing. This scheme was abandoned and was not revived by Watt until his patent of 1784 which included the locomotive engine. To carry out this idea his talented assistant William Murdock made a working model capable of running at a rapid rate, still to be seen in the South Kensington Museum.

From 1720 there had been but few improvements in the Newcomen engine; and with its inherent defects, poor performance, and lack of economy, there was ample field for Watt's genius. This machine, it will be recalled, was an atmospheric rather than a steam engine as we now understand it. A piston was raised by a counterweight, while steam was admitted to the cylinder. At the end of the upward stroke the admission of a jet of cold water into the cylinder served to produce a vacuum by the condensation of the steam, and atmospheric pressure acting on the upper side of the piston forced it down so that through the agency of a connected beam and pump rods water would be raised from the mine. The steam admitted to the cylinder on the upward stroke of the piston forced out the water through a so-called snifting valve.

Watt had studied the properties of steam, and independent of Dr. Black's work he had realized the true significance of its latent heat. In his experiments he applied scientific theory to the economy of steam production in the boiler, studying the action of the steam itself, and more particularly and most important, its behavior in the cylinder. The results were

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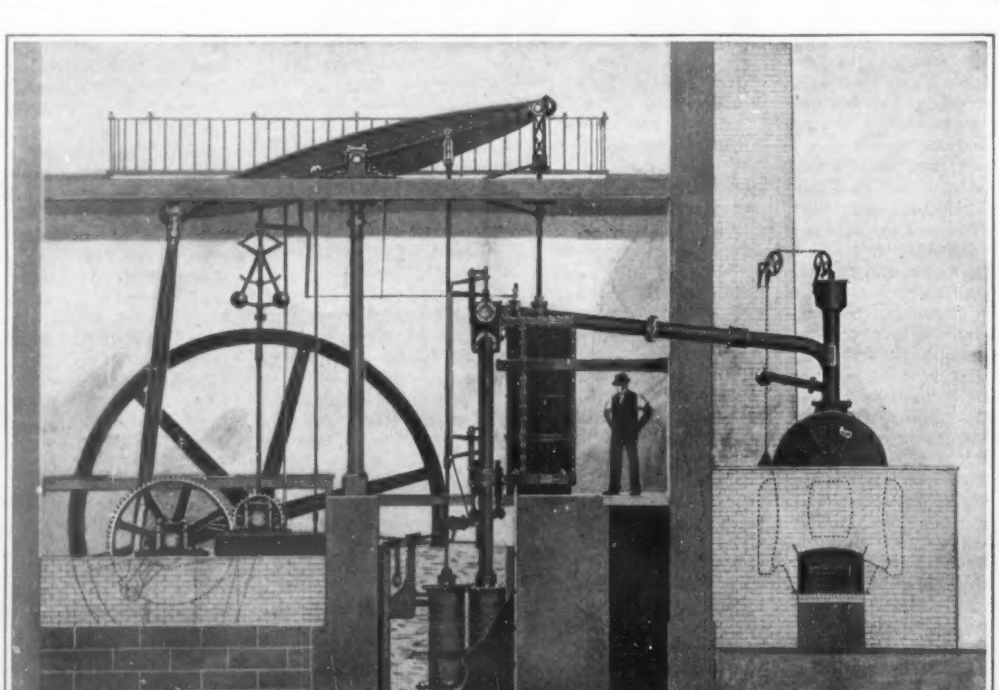
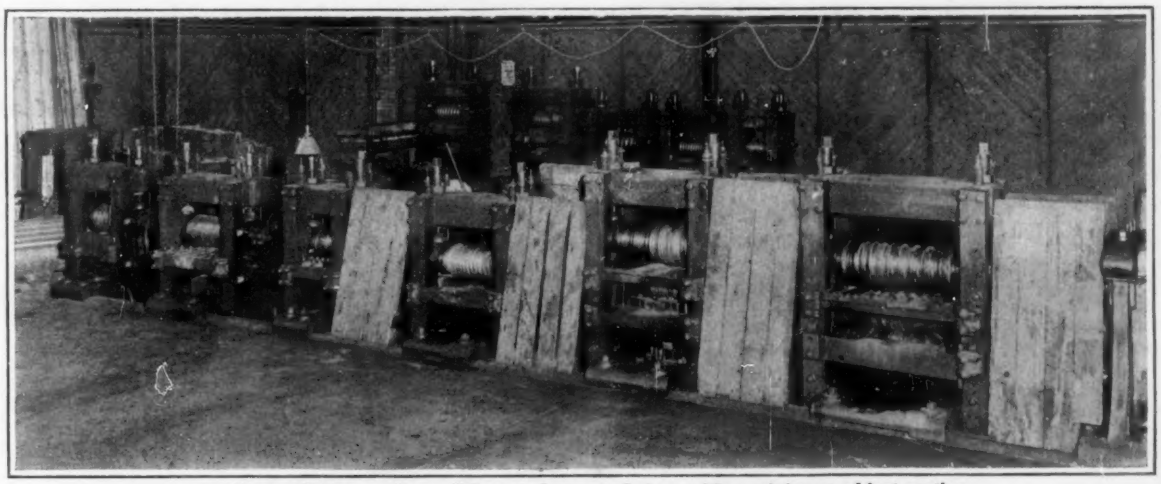


Double-acting rotative mill-engine as designed by James Watt and constructed by Boulton and Watt

A Rolling Mill of Great Flexibility

A ROLLING mill, classed as unique and claimed to be the only one of its kind, is shown by the illustration. In usual rolling mill practice it is necessary, when it is desired to roll different sized bars or other shapes, to change the rolls in each stand or housing. By so doing the shape of the resulting rolled product will be square, round, flat or otherwise, depending on the size and shape of the rolls. But the actual changing of these many steel rolls—the taking of each one out of the stand and the replacing of it with another, is by no means easy and it consumes much time.

The feature of the mill illustrated is that instead of changing the rolls each time it is desired to roll a new shape, it is only necessary to replace one or two stands with others, which contain assembled different rolls. In other words, each stand containing rolls is a machine tool unit, so to speak. In the illustration, there are six stands in a row all ready for use. In the background are five stands containing rolls of still different shapes or grooves. Any one or more of these can be put by means of a crane in place of those in use and thus in a brief space of time a new train of stands is made to roll a new product. The saving in time is important. In a half hour the change can be effected by the new kind of mill while perhaps several hours is needed under the older way.



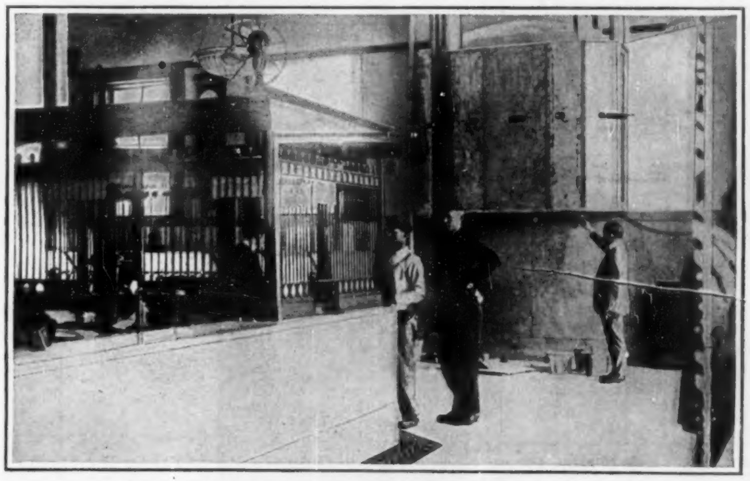
A rolling mill that produces different shapes and sizes with a minimum of lost motion

Steel Blockhouses for the Robber-Proof Bank

THE robbery of suburban banks around Chicago has been so frequent and so successful of late that bankers have had to give no little attention to this unusual phase of banking. How to protect the moneys and securities placed in their care has been a grave problem, but one thinking banker has solved it by installing a steel blockhouse in his establishment.

The steel blockhouse is built into the wall of the building, and can be entered through a narrow door on either side. A number of loop-holes permit guns and machine guns to be used to cover every part of the banking rooms. The steel plate used is of sufficient thickness to resist small-arms fire. The guns of the blockhouse also command the exterior of the building. Night and day a guard is posted in this fortress, ready at an instant's notice to man the guns and machine guns.

So no highwayman can hope to hold up this bank by covering the teller with a gun; he will still have the blockhouse to reckon with.



Built right into the wall of the bank, this steel blockhouse foils any would-be bank robber

Novel Means for Repairing a Worn-Out Pump

THE type of centrifugal pump used by dredging contractors and mining operators for such purposes as dredging silt, sand, mud and gravel from the bottoms of channels and for mining soft ore by the hydraulic mining system, is subject to excessive wear due to the constant abrasion of the sand and gravel against the inner walls of the pump chamber. When the wear becomes so great as to interfere with the operation of the pump, or "sand sucker," as it is commonly called, it becomes necessary not only to put the pump itself out of commission for repair but also to hold an expensive dredging barge and its crew in idleness.

Such a sand sucker chamber that had become badly scored through use was recently restored to practically its original condition by means of the oxy-acetylene process. When it is considered that new castings would have cost about $3,500 and that the actual cost of repairing by welding methods amounted to only one-third as much, it is not surprising that the contractor decided to repair instead of to replace, especially in view of the still more important fact that repairing enabled him to get the dredge back into service with only a few days' delay, whereas replacement meant a delay of from 10 to 12 weeks.

In order to gain some idea of the cost of delay of a hydraulic dredging outfit an estimate of the earnings of a dredge will be given. In the year 1912 the United States Government estimated the cost of hydraulic dredging to be 7.18 cents per cubic yard. This figure represented the average total unit cost of operating a fleet of hydraulic dredging vessels. The record for one month for one dredging pump having a 20-inch outlet pipe was 456,000 cubic yards of material. At the average unit cost given above, the monthly cost of dredging this amount of material represents over $30,000. The sand sucker shown in the illustrations is much larger than the one referred

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Building up the inside of a worn pipe chamber with the acetylene welder, and a view of the 14-foot casting designed to show the magnitude of the job

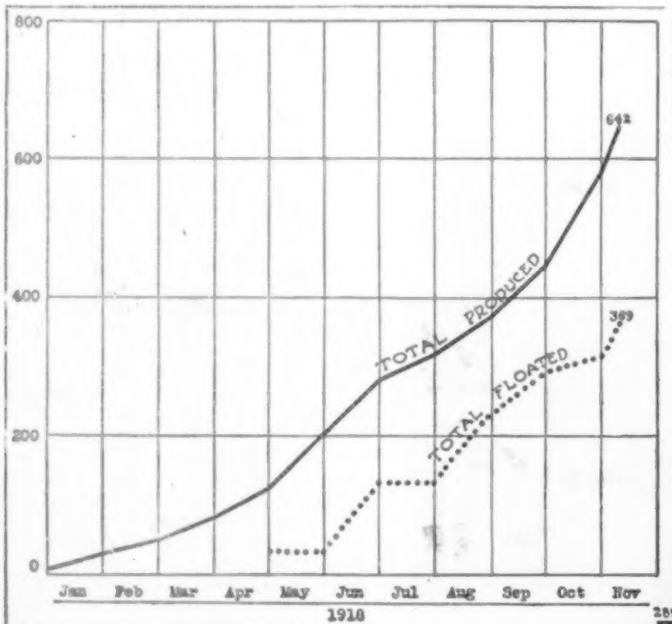
Our Technical Achievements in the Great War—V

Providing the Equipment and Training the Forces for a Great Flying Force

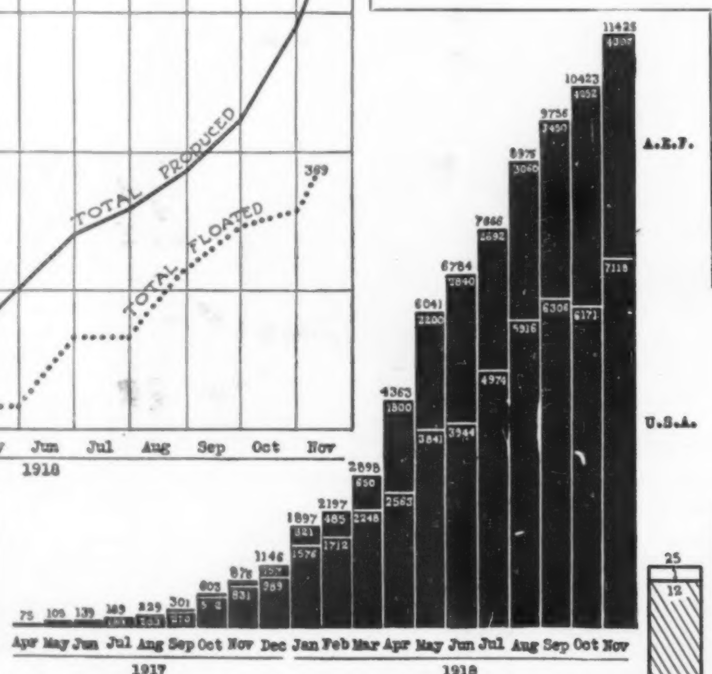
UPON our entrance into the war in April, 1917, the United States possessed only two aviation fields and 55 serviceable airplanes. This was bad enough; but when the National Advisory Committee on Aeronautics which had been conducting a scientific study of the problems of life, advised that 51 of these airplanes were obsolete and the other four obsolescent, the situation certainly looked to be desperate.

At the very outset, the Allied Governments, and particularly the French, urged the necessity of sending 4,500 American aviators to France during the first year, if superiority in the air was to be gained by the Allies. Moreover, they asked that these men be trained and sent over with all possible sp:ed. When the European flying instructors reached here, they admitted that the 4,500 schedule was not practicable, and that the best that could be done was to approximate the program as far as possible.

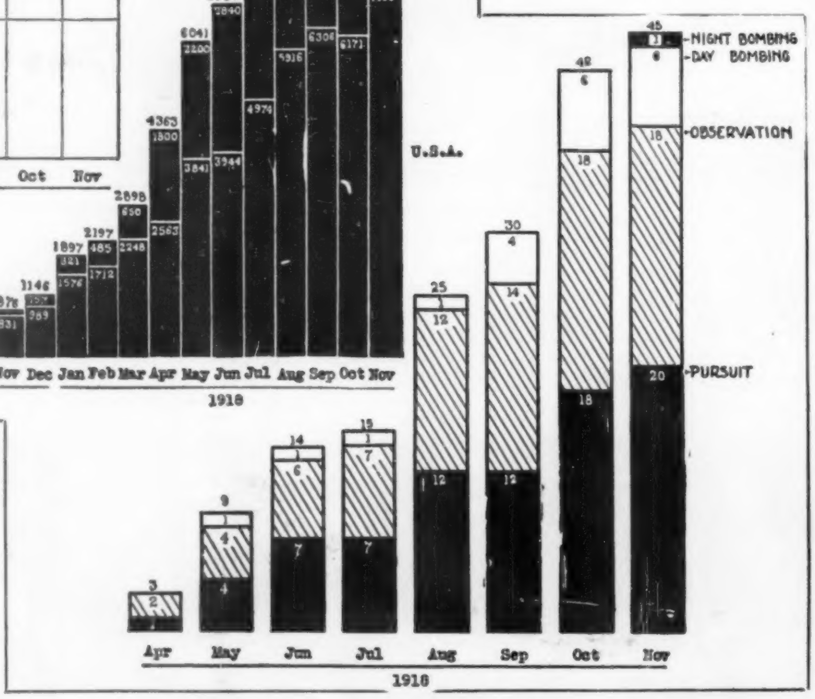
Now in the building up of an aviation service, three things were essential: training planes, aviators, and service planes; and these, because of the obsolete character of the few planes which we possessed, had to be created from the ground up.



Observation balloons produced and number shipped overseas each month



An erican flying officers in France and in the United States each month



Nur ber of American air squadrons in action each month

Training the Men

"Before the war," says Col. Leonard P. Ayres, "our air service had been small, struggling, and unpopular. Aviation was restricted to unmarried officers under thirty years of age, and offered no assured future as a reward for success . . . it was not an organization upon which a great industrial expansion could be built."

Training for aviation is done in three stages—elementary, advanced and final. Elementary training includes physical training, various practical and theoretical military subjects, the study of the structure and mechanism of airplanes and engines, signalling, observation, and elementary flying up to the point of doing simple flying alone. This is followed by advanced training, which consists in the specialized work necessary for the student to qualify as an all-round pilot or observer. When an officer has been through this stage he is ready to master quickly any type of machine or any kind of observation or bombing duty. The final training, which was given in Europe, was a short intensive specialization on the type of machine or the military problem to which the aviator was finally assigned.

The statistics at the date of the armistice tell the story of our great effort in this field; for on November 11th, we had 34 fields in operation with 1,063 instructors, and 8,602 men had been graduated from elementary training and 4,028 from advanced training. At that time there were actually in training 6,528 men. We had sent to Europe more than 5,000 pilots and observers of whom 2,226 were still in training and 1,238 were on flying duty at the front.

Providing Training Planes and Engines

The fact that we had only the 55 training planes on hand, when the Allies asked us to provide 4,500 aviators, will show why the production of training planes was the problem of greatest immediate concern. Deliveries of primary training planes began in June, 1917. At the date of the armistice over 5,300 had been produced including 1,600 of a type which was abandoned on account of unsatisfactory engines.

It was not until early 1918, that advanced training planes reached quantity production; and at the date of the armistice, 2,500 had been delivered. About the same number was purchased in Europe for training the units which were with the Expeditionary Force.

In the matter of engines our allies had demonstrated that the maintenance of a squadron requires more engines than planes for replacements. British experience showed that it was necessary to produce two engines for each plane and this practice was followed in American estimates. Quantity production of training engines was reached in 1917 and, at the armistice, a total of nearly 18,000 training engines and over 9,500 training planes had been delivered. Of the engines, all but 1,346 were built in the United States; and of the 9,500 elementary training planes, more than 8,000 were of American manufacture.

The Production of Service Planes

As soon as war was declared, all the secrets of the great improvement in airplanes were placed at the disposal of an American Commission which went abroad to select types of service planes for production in the United States. The Allies urged us to concentrate on the more stable observation and bombing machines, leaving the production of pursuit planes to the European factories, which were in close contact with the front. A controlling factor in the selections made by our Commission was the necessity of redesigning the models so as to take American-made motors; for foreign engine production was insufficient to meet the needs of the Allies themselves. The Commission selected four types: The DeHavilland-4 (British) observation and day-bombing machine, the Handley-Page (British) night bomber, the Caproni (Italian) night bomber, and the Bristol (British) two-seater fighter. This selection was approved by the French and British authorities.

The redesigned DeHavilland-4 proved to be a good, all-round plane of rather poor visibility, with a tank design which increased the danger in case of a crash, but with these defects more than compensated by unusually good maneuvering ability, and great speed. The DeHavillands were acknowledged to be the fastest observation and bombing planes on the western front. At the time of the armistice this plane was being produced at a rate of over 1,100 per month. A total of 3,227 had been completed, 1,885 had been shipped to France, and 167 to the zone of the advance. The Handley-Page was redesigned to take two high-powered American motors, passed its tests, and on the date of the armistice, parts for 100 had been shipped abroad for assembly.

Delay in the receipt of plans for the Caproni greatly retarded the redesign of this machine. Successful tests of the new model were, however, completed previous to the armistice. The Bristol fighter was a failure. The changes necessary to accommodate the American engine so increased the total weight as to render the machine unsafe.

By the end of November, 1918, we possessed 7,900 service or battle planes of which nearly 4,100 were of American manufacture and 3,809 were of foreign manufacture.

Service Engines

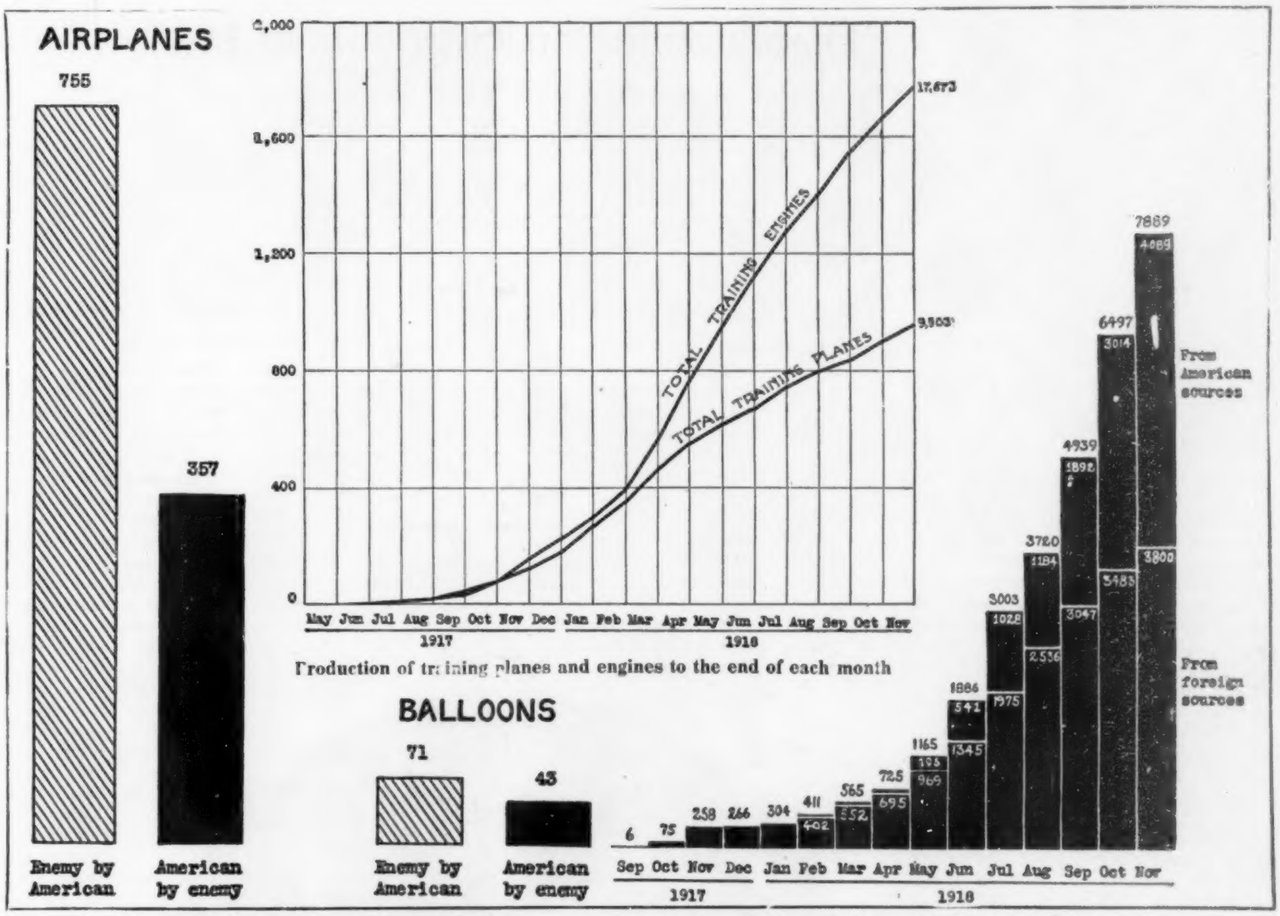
The rapid development of the heavier types of airplanes and the pressing need for large-scale production, made necessary the development of a high-powered motor adaptable to American methods of standardized quantity production. This need was met in the Liberty 12-cylinder motor, of which we produced a total up to the date of the armistice of 13,574. Of these, 4,435 went to our Expeditionary Forces, and 1,025 were delivered to the British, French and Italian Air Service. Furthermore, we had under development the Hispano-Suiza 300 horse-power, the Bugatti, and the Liberty eight-cylinder. The Hispano-Suiza 180 horse-power had reached quantity production, and 469 of this type were produced.

Up to the end of November, 1918, the total number of service engines secured was over 22,000. About 16,000 of these were from American sources, and about 6,000 from foreign sources.

Raw Materials and Accessories

It is not possible within the limits of this article to describe in detail the vast operations involved in securing the needed quantities of spruce and fir (of which 174,000,000 feet were delivered) or the castor oil for

lubrication or the development of a fabric to take the place of linen. Among the accessories was the oxygen mask, the military parachute, electrically-heated clothing for the aviators, long-focus, light-filtration cameras and the wireless telephone.



Airplanes and balloons brought down in action

Production of service planes to the end of each month

The Production of Balloons

The wonderful story of our manufacture of observation balloons and shipment overseas is told in one of the diagrams. In no field did American manufacturing capacity achieve a greater relative success. Before the armistice we had produced 642 observation balloons and had received 20 from the French. Forty-three of our balloons had been destroyed and 45 given to the French and British.

This left us with 574 balloons at the end of the war. On the same date the Belgian Army had 6, the British 43, the French 72, and the Germans 170 on the western front. These figures mean that at the end of the war we had nearly twice as many observation balloons as the enemy and the Allies combined had at the front.

Forty-Five Squadrons at the Front

The American pilots of the Lafayette Escadrille were transferred from the French to the American service December 26, 1917, flying as civilians until they were formally commissioned in January, 1918, and attached to the French Fourth Army operating over Rheims. Two full American squadrons were attached to the British Royal Air Force in March and June, 1918, and they remained with the British throughout the war, participating in eight separate engagements.

Strictly American aviation operations began in March, 1918, and by the middle of May squadrons of all types—pursuit, observation and bombing—as well as balloon companies, were in operation on a wide front. These squadrons were equipped with the best available types of British and French service planes. The rapid increase in American air forces is shown in the accompanying diagram, the height of the columns indicating the number of squadrons in action each month.

The equipment of American squadrons was in the early months entirely of French and British manufacture. American De Havilland-4's were first used at the front on August 10th, and the number in service increased rapidly from that time on. The rapid rate of destruction of planes at the front is illustrated by the fact that out of the 2,698 planes despatched to the zone of advance, only 1,162 remained at the time of the signing of the armistice.

At the signing of the armistice, there were at the front 20 pursuit squadrons, 18 observation squadrons and 7 squadrons of bombers; with 1,238 flying officers and 740 service planes. There were also 23 balloon companies.

The Test of Battle

The final test of the American Air Service is the test of battle. The final record is the record of the results of combat. Casualty figures are an important part of the record. American aviators brought down in the course of their few months of active service 755 enemy planes. Our losses in combat were 357 planes. This is illustrated in one of our diagrams. The record of our balloon companies shows a somewhat less favorable comparison between our own and enemy losses, the figures being 43 Americans and 71 German balloons destroyed.

The Atlantic Fleet and the Panama Canal

AMONG the various considerations that led the United States Government to build the Panama Canal, the most urgent, undoubtedly, was the desire to bring the Atlantic and Pacific seaboards into close relationship. The new bond that was to be thus established would be two-fold—commercial and military. Of the commercial advantages nothing need be said—they have been manifold from the day on which the first merchant ship passed the canal.

The military advantages of the great waterway are many, and in no direction are they so immediate and invaluable as in the added efficiency and mobility which has been conferred on the United States Navy. Before the canal was cut any warship or fleet of warships that was called upon to pass from the Atlantic to the Pacific, or *vice versa*, was confronted with a 14,000-mile trip. Most of us recall the ever-famous run of the battleship "Oregon" from San Francisco, where she was built, to join Admiral Sampson's fleet in the West Indies. Nor shall we ever forget the anxiety with which her progress down the Pacific and up the Atlantic coast was watched by the nation.

There is no doubt that the strategical situation during the Spanish war proved to be a powerful incentive to the purchase of the French rights at the Isthmus of Panama and the completion by the United States of the great waterway. From the day on which it was opened, it became possible adequately to protect our coasts on either ocean; whereas, so long as the only route from the Atlantic to the Pacific involved a journey of 14,000 miles, it was necessary to maintain the bulk of our fleet where the bulk of our wealth lay, namely, on the Atlantic Seaboard. It had always been a matter of concern to the Navy Department that the Pacific Coast and its great seaports were so far removed, geographically, from the bulk of our fighting fleet that it could receive no immediate assistance in case of attack.

The cutting of the canal has changed all that; and the rapid growth of our fleet, due to the war, now makes it possible to maintain two powerful battleship fleets, one on the Atlantic, the other on the Pacific, under such conditions that the whole fighting strength of the Navy can be concentrated in either ocean within two or three weeks' time.

The new Pacific battleships' fleet, which is shown in our illustrations passing through

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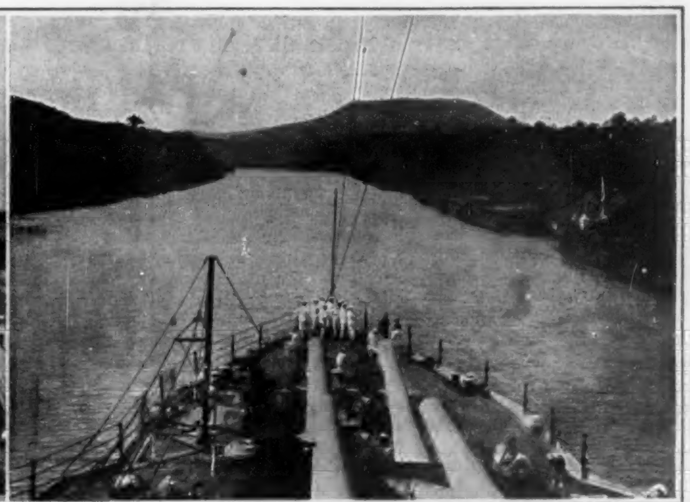
A dreadnought towed through locks by electric towing engines



Pacific battleship fleet passing through a stretch of the Panama Canal

The Heavens in September, 1919

The Census of the Stars and What We Know About Them

By Henry Norris Russell, Ph. D.

THE stars in the sky are almost innumerable; but the number about which we possess information varies widely, according to the nature of the knowledge we are seeking. If we want merely a chart, on which the star can be marked for identification, photographs are already in existence which show many millions of stars—just how many nobody knows, for nobody has found time to count them. If we ask in addition that the star's position in the sky and its brightness shall have been measured, at least roughly, and recorded in a catalog, our lists will still contain well over a million stars; but this number will drop to somewhere between one and two hundred thousand if we demand that the measures shall have been made accurately.

Our list remains very large if we require knowledge of the spectra of the stars; for the new catalog now being prepared at Harvard will contain more than two hundred thousand entries. If we wish to study stellar motions, our lists must be limited to fifteen or twenty thousand stars for which the "proper motions" across the heavens are known, and perhaps twenty-five hundred whose motions of approach or recession have been observed with the spectroscope. The list of double stars runs to about twenty thousand, while the number of known variables is some three thousand.

The number of available objects is still further reduced if we require to know the distances of the stars, or their real brightnesses compared with that of the sun. Though great additions have been made to knowledge by direct measures at several observatories, and by the remarkable spectroscopic method developed at Mount Wilson, the number of stars whose distances or real brightnesses are known does not exceed a thousand.

Should we demand, in addition, information about the masses of the stars, we find that our list has shrunk to a few dozen entries, and that for many, even of these, the data are none too certain. Finally, if we ask concerning the actual sizes of the stars—their diameters—our once enormous list will have become so scanty that its members could almost be counted on the fingers of one hand.

The reason for these remarkable differences is fairly obvious. When information is easily obtainable, our lists are correspondingly extensive. When comparison of observations made many years ago with those recently obtained is necessary, our lists shrink. Where only the brighter or nearer stars are available, they diminish still further; and when the desired information cannot be obtained on any terms unless the star has certain peculiarities, and is observable in several different ways, we naturally are limited to a very few instances.

In view of the scarcity of the cases in which the actual diameters of the stars can be found, a recent communication from Mount Wilson is of special interest, since it adds two more pairs of stars to the all-too-short list.

As the reader familiar with this topic will at once realize, these stars must be double; they must be close pairs, in rapid orbital motion; they must mutually eclipse one another at every revolution, and they must be bright enough to be observed with the spectroscope, so that their orbital velocities can be measured. The very few bright stars which satisfy these exacting conditions have long ago been observed. It is only by utilizing the great power of the sixty-inch reflector at Mount Wilson that Adams and Joy have succeeded with fainter stars.

Cross-Examining the Stars

The first of the two systems upon which they report is of unusual interest—a star of about the eighth magnitude, bearing the name *Mu Ursae Majoris*. It has been known for many years that this star consists of two components, which alternately eclipse one another at intervals of four hours—the complete revolution occupying eight hours. Now the spectrograms show, as was to be anticipated, that the two stars are nearly equal in brightness, and that they are in rapid motion along their orbits at rates of about 130 and 190 kilometers per second. It follows that the two stars are 1,500,000 kilometers or about 940,000 miles apart, from center to center. From the lengths of the eclipses and other characteristics of the variation in brightness it is found that the two are approximately equal in size and strongly ellipsoidal in shape, being pulled out into egg-shaped masses by their mutual attraction, and presenting their small ends toward one another. The longest diameter of each is 680,000 miles, leaving a gap of 260,000 miles between their surfaces. The short diameters, at right angles to the orbital plane, are 470,000, while the third dimension along the diameter perpendicular to both those given, is in each instance 510,000 miles. These stars are therefore much smaller than the sun, which is 864,000 miles in diameter, and the bulk of each is a little less than a quarter the sun's. The masses, which may readily be calculated, are respectively 69 and 49 per cent of the sun's mass. It follows that the fainter component is about twice as dense as the sun, and the brighter one almost three times the sun's density—that is, four times as dense as water, and denser than any of the planets of our system except Venus and the earth. Such stars must be well toward the limit of possible contraction and hence at a late stage of evolution. The spectra of both are similar to that of the sun, and the two together are probably about as bright as the sun—in which case their distance is about 130 light years.

The second system which Adams and Joy have studied is a star of the seventh magnitude listed as *Zeta Herculis*. In this case one of the stars is about twice as bright as the other, and the period of revolution is almost exactly four days. The spectroscopic observations show that the components are 6,500,000 miles apart, and that the brighter star is more massive than the other. Adding the information derived from the eclipses, it appears that the diameter of the brighter star is 1,500,000 miles (nearly twice that of the sun) and that of its fainter companion 2,800,000 miles, or more than three times the sun's. The clear space between the stars is in this instance 4,350,000 miles, or half as much again as the diameter of the larger star.

The mass of the brighter star is 1.6 times, and that of the fainter star 1.3 times, that of the sun. It follows that the brighter but smaller star is about one-third as dense as the sun, while the fainter but larger component is but 1/27 the sun's density. Both stars have spectra of the type called F2 at Harvard (intermediate between Canopus and Procyon) and are probably a good deal hotter than the sun. It is likely that the smaller and denser one has already passed its highest temperature, and is cooling down, while the larger one, which on account of its low density must be entirely gaseous, is still growing hotter as it contracts. The estimated distance of the system is 320 light years.

It is to be hoped that further work with the great telescopes will soon add several more systems to the list of those whose actual dimensions are known.

The Heavens

We may begin our glance at the evening constellations with the great square of Pegasus, which is high in the southeast and unmistakable. Its western side, extended far to the southward, points to the bright star Fomalhaut, in the Southern Fish. Its eastern edge, also extended southward but bent a little to the left, reaches *Beta Ceti*—a star of the second magnitude, standing very much alone. The remainder of this large constellation, which lies farther to the left, is easily made out with the aid of the map. From the northeastern corner of the great square extends a line of second magnitude stars through Andromeda to Perseus. Beyond and below is Capella, one of the brightest of the stars. Below Andromeda is Aries, and Taurus is just rising.

Cassiopeia and Cepheus are high in the north; Ursa Minor and Draco are on the left of the Pole; and the Great Dipper is on the horizon below them. Cygnus and Lyra are high in the west, with Hercules and Corona below the latter. Aquila is well up in the southwest, and below it the Milky Way extends into Sagittarius, which is setting.

At 12 o'clock: Sept. 6.
At 11½ o'clock: Sept. 14.
At 11 o'clock: Sept. 21.
At 10¾ o'clock: Sept. 30.
At 10 o'clock: Oct. 7.
At 9½ o'clock: Oct. 15.
At 9 o'clock: Oct. 22.

The hours given are in summer months time

NIGHT SKY: SEPTEMBER AND OCTOBER

The Planets

Mercury is a morning star until the 26th, when he passes behind the sun and becomes an evening star. He is best visible at the beginning of the month, when he is farthest from the sun, and rises at 5 A. M. (Summer Time) or an hour and a half before the sun, and should be easily seen. He is on the west of Regulus, which he passes, at a distance of less than a degree, on the 8th.

Venus is an evening star till the 12th, when she passes directly between us and the sun (though not in a direct line) and becomes a morning star. Being far south of the ecliptic, she is poorly placed for observation, and can hardly be seen until the end of the month, when she rises at 5 A. M.

Mars is a morning star in Cancer and Leo, rising at 3:30 A. M. in the middle of the month. Jupiter is close by and the two planets are in conjunction on the 2nd, and less than a degree apart.

Saturn, too, is a morning star, in Leo, practically invisible at the beginning of the month, but rising at 4:20 A. M. at its close. He is in conjunction with Mercury on the 10th, the two planets being only seven minutes apart; but too near the sun to be easily seen.

Uranus is in Aquarius and well observable. His position on the 2nd is 22h 7m 0s—12° 27′, and on the 30th, 22h 3m 2s—12° 47′, which places him about two degrees northeast of the fourth magnitude star *Iota Aquarii*, and very close to a star of the fifth magnitude which lies midway between *Beta* and *Delta Aquarii*.

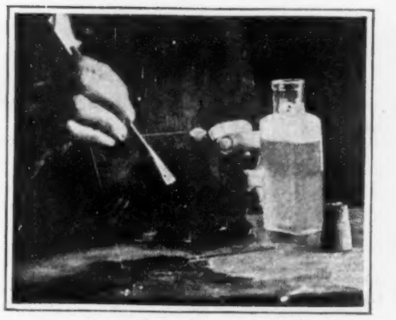
Neptune, in Cancer, is just observable after dawn.

The moon is in her first quarter on September 2nd, at 10 A. M.; full at midnight on the 9th; in her last quarter at 6 P. M. on the 16th; and new at 1 A. M. on the 24th. She is nearest the earth on the 12th, and farthest away on the 1st and 29th. During the month she passes near Uranus on the 8th, Jupiter and Neptune on the 20th, Mars later on the same day, Saturn and Venus on the 22nd, and Mercury on the 24th.

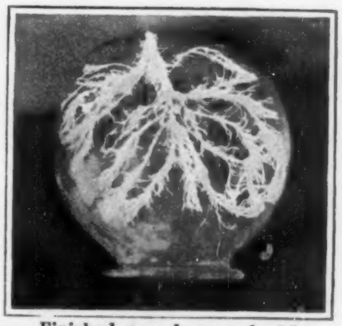
At 11 P. M. on the 23rd the sun crosses the celestial equator, and enters the "sign" of Libra, and, in almanac phrase, "Autumn commences."

Decorating Vases With Frost Flowers

THE plan by means of which frost flowers may be captured has already been described in the SCIENTIFIC AMERICAN. It is interesting to employ the idea for the decoration of glass vases. Some very striking effects can be secured with a small amount of trouble First of all a two per cent solution of gelatin is made in distilled water. Before actually trying to decorate a vase it is a good plan to make some tests on a sheet of plain glass. The beauty of the frost flowers seems to vary a great deal partly according to the degree of cold. When some good formations seem likely we may take the vase and smear it over with the gelatin solution. In a short while it is seen that the keen air is having its effect. The freezing takes the water from the colloidal part of the solution, and this is now designed in the form of flowers and foliage. In a higher temperature the solution will quickly go back to its original condition, but it is easy to render the frost flowers permanent. Pour absolute alcohol over the surface of the vase (this may be used again and again) so that all the ice is removed. This will only be a matter of a minute or so. After this allow the gelatin to set dry, and then varnish with an alcoholic solution of shellac. Some very pretty effects in the way of decorated vases may be obtained in the manner described.



Preparing plain glass to test degree of frost

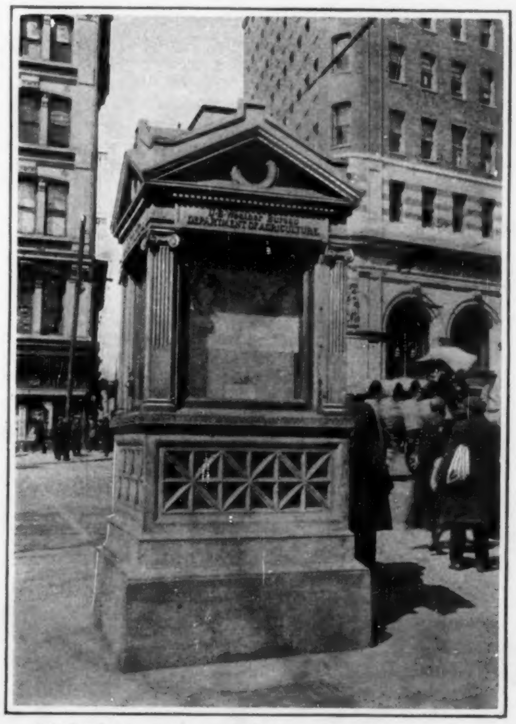


Finished vase decorated with frost-flowers

A Weather Bureau for the Street Corner

NO matter what may be taking place in this big world of ours, the topic always foremost in the minds of everyone is the weather. Not only are we interested in the present state of the weather, but we also seek advance information from the weather man. And after all that is perfectly logical; for does not the weather materially affect our daily life and tasks, no matter what they may be?

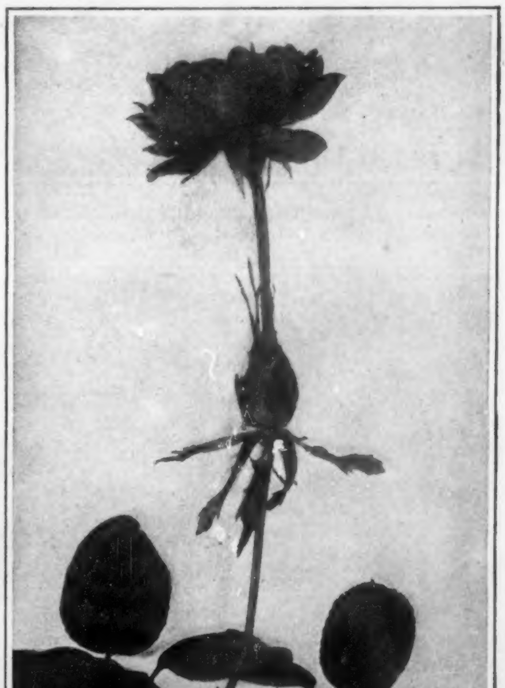
There are many American communities where each citizen can be his own weather forecaster. Hartford, for instance, is one of them. In the center of that Connecticut city there is an attractive structure of stone and metal, containing quite a collection of weather forecasting apparatus behind glass windows, in order that they may be studied by anyone. Among the equipment is a precipitation gage, aneroid barometer, thermograph, humidity indicator and several types of thermometers. But that is not all; the apparatus occupies only one window, and the others are devoted to weather forecast bulletins, wind charts, storm warnings and other similar information from the Weather Bureau.



All the information one desires about the weather is obtained at this street booth

A Curious Rose

FLOWERS seem so highly specialized that one does not associate them with the vegetative or growing part of the plant. Yet there is no doubt that blossoms have had a leafy origin, even though this is not always very obvious. A strange case of a flower breaking away into a shoot is shown in the accompanying photograph. A rose bush growing in a garden in Natal, South Africa, was responsible for the curiosity. The bud, instead of expanding into a flower, sent up a stalk at the end of which was borne a rose that was finely developed.



A flower bud that disregarded the conventions

The Current Supplement

DURING the war all the armies concerned were compelled to develop what is perhaps a wholly new art, that of photographing the earth's surface from flying planes, and also the art of interpreting the photographs thus secured. The knowledge and experience thus gained it has been proposed to employ in peace-time mapping of more or less inaccessible territories and a well-illustrated article recording the *Recent Progress in Aerial Photography* published in the SCIENTIFIC AMERICAN SUPPLEMENT No. 2278, the issue for August 30, 1919, the current SUPPLEMENT, will be found of quite general interest. Of related interest to the mapping of the earth's surface, is the origin of the features thus mapped. A very interesting attempt to expound the laws regulating the courses of rivers is given in an illustrated article on *How River Bends Are Formed.*

The development and present lines of usefulness of *The Electric Furnace* together with some predictions of the probable lines of its future development are presented in a well-illustrated article under that caption; while a short paragraph discusses the usefulness of *X-Rays for the examination of steel furnace electrodes.* Those who have other interests than purely commercial ones in physics and chemistry will be interested in the brief illustrated resumé of devices for determining *Viscosity.* An interesting article is the unillustrated exposition of the construction, operation, and economy of the *Semi-Diesel Engine,* sometimes known as the hot-bulb or surface combustion engine. Among the profits we may expect from the war are those arising from the great limitations under which the Central Powers in particular had to work, and one of their valuable studies which tended toward improving reactions in the mixer and in basic open-hearth steel practice is presented in the article *Desulphurizing in the Pig-Iron Mixer.* An interesting account of preliminary preparation and study of *Yttrium Mixed Metal,* a mixture analogous to cerium mixed metal but heretofore not successfully studied, and a discussion of certain features of *Cloud Negatives* secured for the purpose of "printing in" on foreign landscapes, are among the shorter articles.

The very interesting conclusion of the article *How Honeybees Produce Honeycomb* will also amuse some readers.

Nitrogen Fixation

AMERICA'S improvements on the Ostwald process for oxidizing ammonia to nitric acid are as valuable in peace as in war. The Semet-Solvay plant passes ammonia and air in a 10 per cent mixture over a platinum gauze maintained at a temperature of about 825 degrees C. The gauze is woven of wire 0.0026 inch diameter 80-mesh per linear inch and weighs about 16.5 ounces. The gas flow of 200 cubic feet per minute represents a nitric acid capacity of about two and a half tons a day. In preheating the mixed gases only pipes of nickel, aluminum or silicate can be used as other materials decompose the hot ammonia. The Secretary of the American Chemical Society estimates that this process based on a cost of producing ammonia at 11.5 cents per pound can compete with nitric acid made from Chili nitrate when that raw material costs as low as 2 cents per pound.

Durability of Untreated Piling Above Low Tide

IN tidal waters the portions of piles above mean low tide, although completely immersed only part of the time, may be practically saturated all the time. Wood constantly saturated with water is not subject to decay, and this fact makes the height to which saturation extends above low tide a question of considerable interest to the designing engineer.

The opinion of a number of engineers and construction companies, expressed in response to inquiries by the Forest Products Laboratory at Madison, Wis., is that untreated piling in water not infested with marine wood-borers will remain sound indefinitely if cut off at half tide. This height ranges in various ports from 2.3 to 4.5 feet above low water. At certain places on the Atlantic coast, piles cut off at the height of half tide are still sound after from 50 to 100 years of service.

Untreated piling is destroyed by marine borers more rapidly than by decay, and the information given would, of course, have no practical use where these organisms are active.

Weaving Wicker by Machinery

ONE million dollars was refused by Marshall B. Lloyd, of Menominee, Mich., for his new method of producing reed and fiber goods and his machine for weaving the fabrics.

A group of American men interested in the manufacture of baby carriages, furniture and baskets inspected the device in Mr. Lloyd's factory and saw, for the first time in the history of the world, so it is claimed, a machine that would weave reed and fiber. Up to the present time this costly operation has been done by hand. The Lloyd loom, however, will weave the fabric thirty times as fast as the most expert hand worker can and with far greater superiority.

A sum of $1,000,000 was made up by the manufacturers during the noon hour and offered Mr. Lloyd. He turned it down. A short while ago the Australian government purchased rights to Mr. Lloyd's inventions for $250,000 in order to give industrial assistance to returned wounded soldiers. The sight of a one-armed man operating the machine in the Lloyd plant here convinced the Hon. G. M. S. Manifold, member of the Australian parliament, that his country needed the machine to help out its returned and crippled heroes.

One million dollars has been raised here for the erection of a factory in Menominee in which the Lloyd method of production and loom will be used. Construction of a plant that will employ 800 men and women is now well under way. When completed it will probably be the largest baby carriage and woven furniture factory in the world.

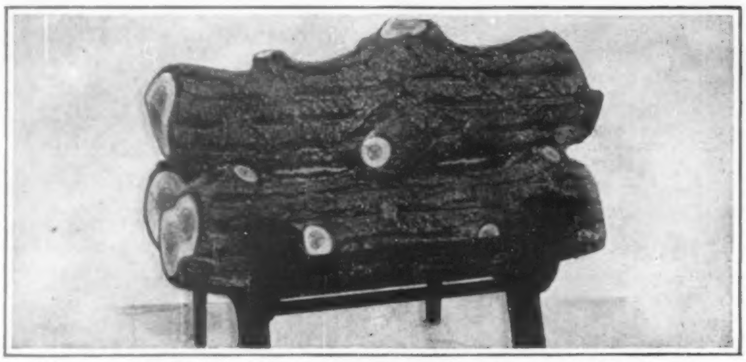
Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

Electric Logs for the Fireless Fireplace

IN city homes and in cases where the usual logs are difficult to obtain and still more difficult to burn in the fireplace, it is the usual practice to make use of artificial logs which contain numerous gas burners. However, because of the frequent escape of gas as well as the soot and dirt that go with the use of gas, there has been a tendency of late to turn to electrically-operated logs.

The logs shown in the accompanying illustration are of the electrically-operated type. Tough, hard-burned terra cotta is used as the base, and is carefully shaped and colored to represent logs in operation as well as cold. The heating elements consist of resistance wire, and the life of these elements is estimated at more than 2,000 hours. The elements can be easily replaced at a small expense when exhausted. The wires are coiled in the imitation bark crevices and remain so inconspicuous that they escape detection when cold.



These very realistic-looking logs operate on electric current without flame, smoke or dirt

The logs are made in 20-inch lengths, and take approximately 2,000 watts of current on either direct or alternating current. Hence the cost of operation is anywhere from 2 to 5 cents per hour, depending on the cost of current.

Letting the Automobile Crank the Airplane

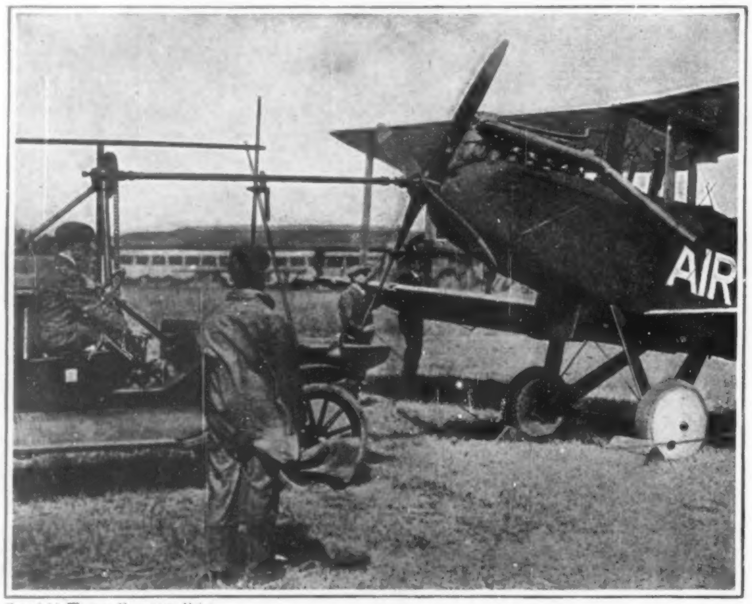
AIRPLANES can never be considered practical in the full sense of the word until hand cranking is done away with. It is only a matter of time when all machines will be equipped with some form of self-starter; but in the meantime there are numerous machines which have no self-starting system and call for the troublesome and dangerous hand cranking.

It has remained for some Britisher, with a good head for improvision, to build the simple cranking device shown in the accompanying illustration. Instead of having a mechanic grasp the propeller and give it a sharp twist, being careful not to be caught in the sudden start of the blades, the motor-driven cranking outfit here depicted is now being employed at the Hendon flying field in England. By means of a simple clutch the power from the automobile engine can be diverted through chain drive and shafting and a universal joint to the propeller hub. It goes almost without saying that this motor-driven starter is used in connection with existing planes that are not provided with self-starters.

Hangar of Canvas That Is Stronger Than One of Steel

SINCE aviation became a scientific demonstration instead of a theory, it has been the endeavor of aviators and engineers to construct a portable hangar that would combine ample working space without waste of material, strength in wind resistance sufficient to withstand storms even when they approach cyclonic velocity, and ease of egress and ingress. During the war the Aviation Section of the War Department made numerous experiments along this line with indifferent results; but it remained for a practical tent maker of Brooklyn, N. Y., who has spent a lifetime in the study of canvas construction and its relation to ground air currents, to devise a hangar that apparently meets all of these requirements.

The hangar shown in the accompanying views is practically windproof, and can be readily transported from field to field and rapidly erected by the crew of the airplane which it is to shelter. The width of the hangar is 51 feet, allowing 3½ feet on each side of the plane in the case of the Curtiss JN-4 machine. The walls of the main body of the tent are 12 feet, allowing ample clearance space for the ingress and egress of the plane, yet making the highest point of wind resistance only 13 feet. At this point the hangar is protected by a double set of guys which are built into the tent, and which criss-cross themselves in a manner to balance the strain, no matter from what direction the wind may blow. There is nothing to unfasten or to become unfastened, as the guys passing as part of the top completely over the hangar, are fast to the rings the poles go in. The extension to accommodate the fuselage is of ample size to allow working room, and is designed at an odd slant to shed wind and water, and this is guyed just as substantially as is the main body of the hangar.

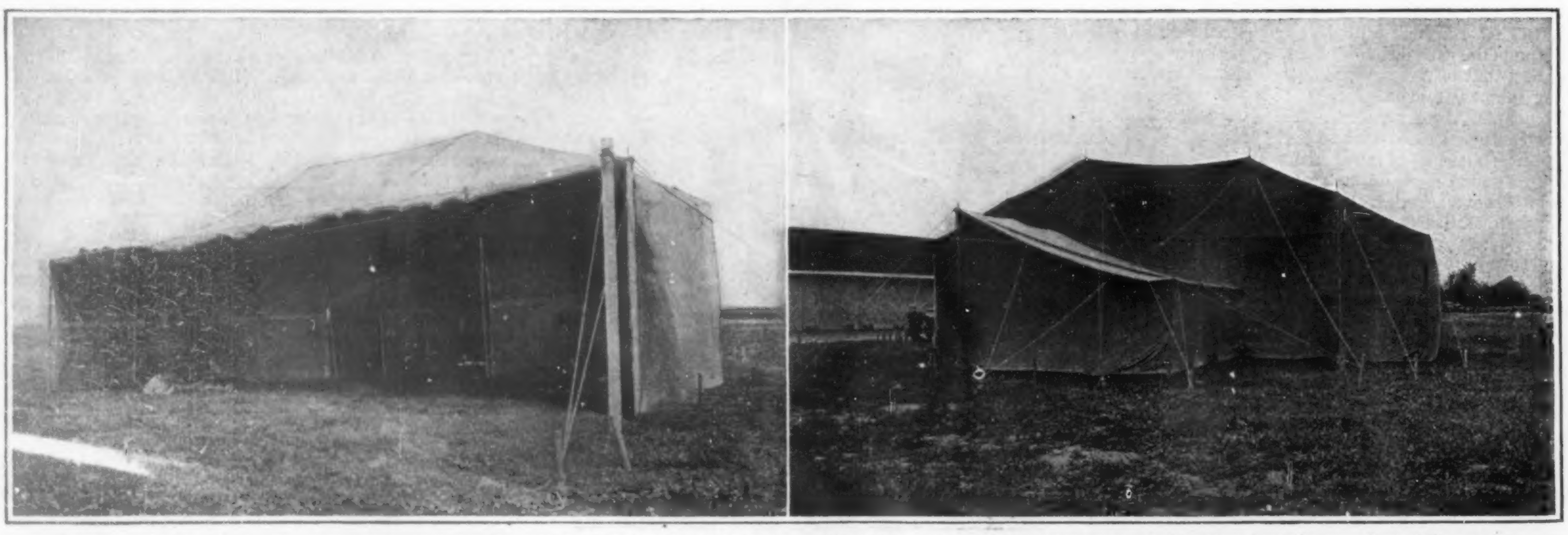


Letting the automobile crank the airplane propeller at the Hendon flying field in England

Electric Night Lamp

A MOST ingenious little night lamp has been introduced by an American manufacturer of fixtures. This device is made of porcelain, and of an odd shape strongly suggesting a Japanese type of lamp. The shade is made an integral part of the base. In the base is a step-down transformer, which reduces 110-volt alternating current to 6 volts, so as to furnish current for a six-volt two-candlepower automobile type bulb. A simple switch is provided for turning the light on and off.

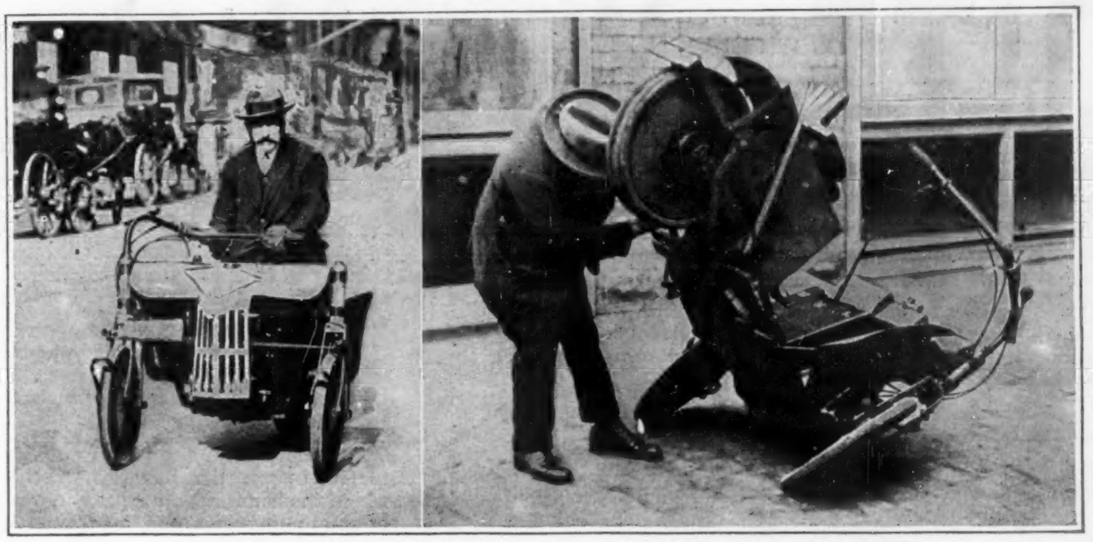
This little night lamp furnishes just sufficient illumination for dimly lighting a medium-sized room, and the bulb is properly shielded so as not to be troublesome. The current consumption is so slight as hardly to make the average meter register.



Front and rear views of a canvas hangar recently tested by the U. S. Air Service, and which has been found to resist wind better than the usual steel hangars

A Three-Wheeled Motorcycle

THERE has recently appeared on the streets of London an ingenious little vehicle which is popularly called the Tankateen. It is a three-wheeled vehicle, taking its general design partly from the conventional motorcycle and partly from the small automobile. It has a three-horsepower motor, which is ample to carry the load imposed by this miniature car. All in all, the Tankateen is an inexpensive vehicle to buy and to maintain, yet it meets the demands of those who prefer something less strenuous than the motorcycle.



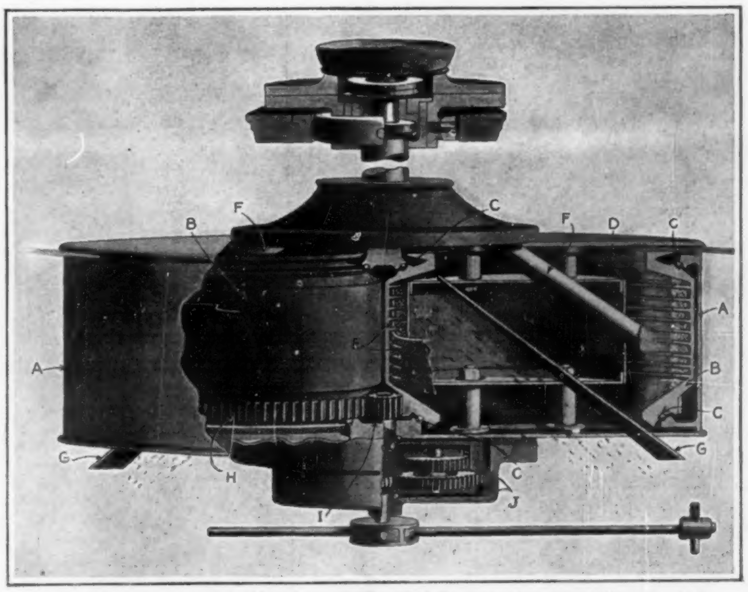
Two views of the new vehicle which is now meeting with much favor in England

Continuous and Intermittent Centrifugal Machines

TIN slime has hitherto presented a serious problem to metallurgists. Because of the mechanical hold of the colloids on the metallic particles, it is impossible to separate the latter with the ordinary concentrating devices which depend upon gravity. The difference in specific gravity between the metal fragments and the colloidal constituents of the slime is so slight that it is not sufficient to disengage them. This has led a South African firm to invent a centrifugal separator of very novel design which by the application of centrifugal force will tear the metal particles from the colloids. With this machine it is claimed that more than two-thirds of the tin which now goes to waste, can be saved.

The machine is novel in the fact that it operates continuously, using centrifugal force not only to pack the solids against the walls of the revolving buckets but also to remove the solids and throw them out of the machine. This is done by the use of a rapidly revolving drum in which there are separate buckets connected by planetary gearing so that they will have an independent rotational movement of their own, and thus the material that is packed against the outer side of the buckets will eventually be carried around to the inner side, where centrifugal action will cause it to be thrown out of the machine.

In one of our drawings we have shown a machine of this type, partly broken away to illustrate its novel construction. The main drum which is driven to revolve at high speed is indicated at A. Within it there are two similar buckets, B, which are mounted on ball bearings C, in the drum A. The buckets are provided with flanges on their inner peripheries to assist in holding the solid material. Within these buckets, but not rotating with them, is a casing D which, at the side nearest the axis of the main drum, is formed with fingers or plows E adapted to fit between the flanges of the bucket B and peel off the solid matter packed therein. The slime to be separated enters the bucket B through a spout F and owing to centrifugal action it is immediately thrown against the outer side of the bucket B, the solids being packed between the flanges and the liquid standing as a vertical wall, as shown in the illustration. As material is fed into the bucket the liquid parts flow over the top of the bucket and are thrown out of the machine. The slow revolution of the bucket B presents constantly a fresh surface for the accumulation of the solid material, and as this material reaches the plows E it is peeled off and thrown out by centrifugal action. The plate G prevents it from passing to the opposite side of the bucket and directs it downward and out of the machine. Both of the buckets operate in the same manner and there is a constant discharge of liquids from the top of the machine and of solids from the bottom. The planetary gearing which gives a comparatively slow motion to the buckets is shown at H, I, and J in our large diagram.

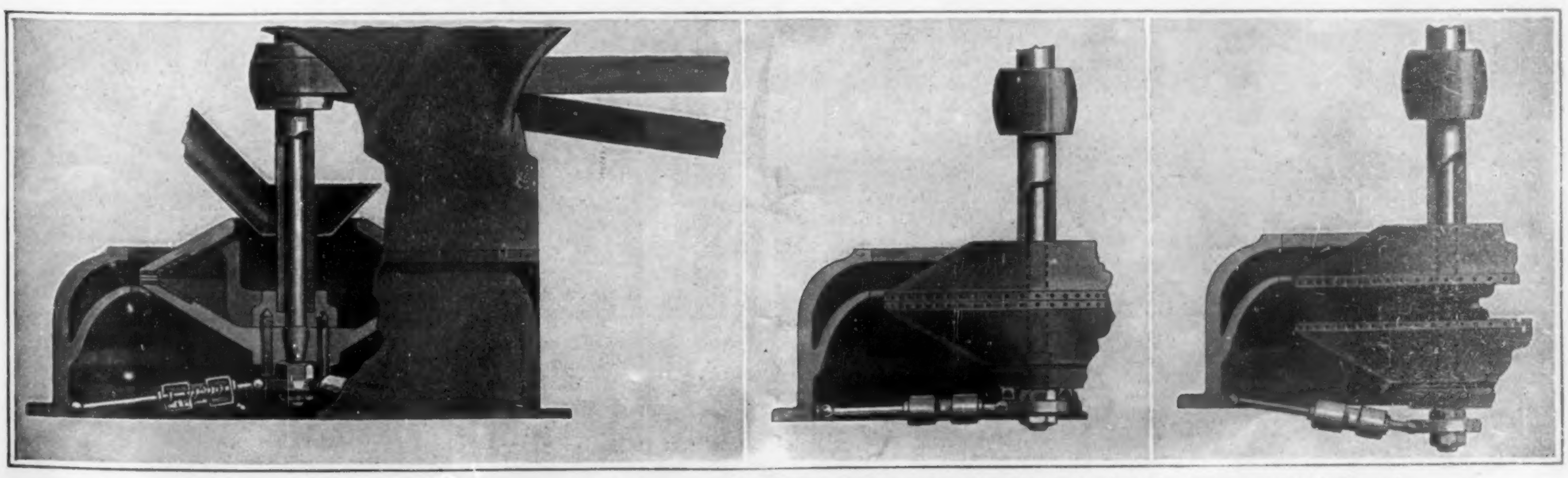


Sectional view of a centrifugal separator which separates crystalline particles from colloidal slime

Obviously a machine such as this has many applications. It could, no doubt, be used for the separation of silver and copper slimes. It was first designed for the separation of the cyanide solution from gold slime and sands, and it has also been proposed to use this machine for the separation of sewage.

There is another centrifugal separator, also a South African product, which is illustrated herewith. This runs continuously but discharges the solids intermittently. It has proved very successful in the separation of soda crystals from the mother liquor. The machine has a simple filtration drum. This drum is two feet in diameter and runs at a speed of 1,400 revolutions per minute, and it delivers about five tons of soda crystals every twenty-four hours. The pulp is fed into the drum and the fluid is discharged through the filter screening and perforated walls into an external launder. When the fluid is discharged the drum is lowered until it comes in line with a lower receptacle. Then the lower half of the drum continues to move downward so that the two halves are parted and the solids are instantly expelled by centrifugal action into the lower receptacle. The operation is now reversed, closing the drum and bringing it up into position to discharge the filtered liquids into the upper receptacle.

A machine of this type, now under construction, is designed to revolve at 2,000 revolutions per minute and is intended for the separation of sugar crystals from molasses. The machine appears to be singularly adapted to the separation of alkalis, lending itself most conveniently to those operations of "fractional crystallization" in which the various salts in a solution crystallize out separately at different temperatures.



Three sectional views of a centrifugal separator which runs continuously but discharges the solids intermittently, in the manner indicated

LYNITE—What it Is and

What does *Lynite* mean?

If you are a motor-car or truck owner, dealer or manufacturer, you may say it means a light-weight metal, or aluminum, or aluminum alloys—you may say it means a piston or a crankcase.

If you are the maker or user of any one of various other products, you may reply that it means a tank cover, a vacuum cleaner part or some other article or articles on which you have seen the *Lynite* trade mark.

Lynite, however, has a meaning much broader than any one or all of these.

It is more than aluminum, for aluminum is but the basic raw material which gives it lightness, making it weigh but a third as much as cast iron.

It is more than an alloy or a group of alloys, because *Lynite* foundry practice is just as essential as *Lynite* formulae to the production of *Lynite.*

It is more than any single part or number of parts, because it stands not alone for a product but also for a service—the kind of service that can be given only by a large, forward-looking organization which does not simply take account of today's production but strives, through scientific research, to develop tomorrow's possibilities.

Fully to understand the meaning of *Lynite* you must know that to a great degree it represents pioneering in the field of aluminum alloys.

The lightness of aluminum, valuable as *Lynite* has made it, was of comparatively little use to the automotive and other industries until means were devised to add to it strength, toughness and hardness.

It remained for the makers of *Lynite* largely to devise or perfect, by scientific means, the methods and processes through which the countless difficulties met in the making and casting of aluminum alloys were overcome.

For the automobile manufacturer and the car owner, however, *Lynite* has a significance beyond all this. To the builder it means a way to eliminate hundreds of pounds of excessively heavy cast-iron from every car and truck, not only because *Lynite* directly lightens those scores of parts in which it

LYNITE

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AIRCRAFT PROJECTILE.—G. L. Lamberson 465 Herkimer St., Brooklyn, N. Y. Among the principal objects of the invention are to increase the effective operating area of a projectile. This air-craft projectile has a hollow chamber body adapted for the storage of coils of flexible lines, weighted members being attached to the ends of the coils, and means for ejecting the members while the projectile is in flight. The object being to strike the wings of a craft with the flying weighted members, or to wrap the lines around the propeller, or some necessary operating element of the aeroplane, thereby disabling the same.

METHOD OF FIREPROOFING AIRCRAFT.—P. R. Bradley, care of Aircraft Fire Proofing Corp., 120 Broadway, New York, N. Y. The invention relates to the method of and means for fireproofing inflammable parts of aircraft and the like. The method consists in applying one or more coats of a fireproof-liquid, made from a combination of ammonium phosphate, boric acid and water, applying an adhesive to the coated parts, applying a foil with a removable backing thereon to the adhesive-covered surface, and removing the backing from the laid foil and coating the foil with a waterproof varnish.

METHOD OF DOPING AIRCRAFT.—P. R. Bradley, care of Aircraft Fireproofing Corporation 120 Broadway, New York, N. Y. This invention relates to a method of applying dope or fireproof-coating liquid to wings and other surfaces of flying machines, without endangering the health of employees, or being an offense to the neighborhood. The method consists in arranging the sections of the aeroplane on suitable dipping frames, submerging the frames and aeroplane parts in a tank containing the liquid, raising the dipped parts out of the tank, and then conducting them through an air-tight drying chamber which has suitable means for drawing off and condensing the vapor and fumes.

Pertaining to Apparel

WOVEN GARTER PAD.—W. Achtmeyer, Middletown, Conn. The invention relates to garters having a pad from which extends a leg encircling band and a hose clasp for gripping hosiery. The object of the invention is to provide a woven garter pad or shield which can be cheaply manufactured in one single piece and which is exceedingly strong and durable, neat in appearance and readily and accurately fits itself to the wearer's leg.

SUSPENDERS.—W. C. Reinmuth, 38 Hammond St., Rockville, Conn. This invention has particular reference to suspender attachments or means connecting the strap or web portion of the suspenders to the trousers or other garment to be suspended. Among the objects is to provide a suspender attachment having a slide support connected to the suspender web, a plurality of tabs for independent attachment to the trousers and a cord having its ends attached to a portion of said tabs and having its intermediate portion slidably connected to the remaining portion of the tabs and the slide support.

SEAMLESS DRESS.—M. Reeser and W. W. Stebbins, 134 So. 7th St., Newark, N. J. The object of the invention is to provide a seamless dress more especially designed for the use of children, preferably made of a washable material, and arranged to permit of conveniently and quickly washing and laundering the dress without requiring removal or alteration of any one of the parts. An object is to provide a dress which is neat in appearance, and which can be cheaply manufactured.

Electrical Devices

SPARK PLUG.—A. J. Perron, 404 So. K St., Sparta, Wis. An object of the invention is to provide a spark plug having an almost entirely closed shell for the purpose of protecting the central electrode, the floor of the shell being disposed at an angle to cause any possible accumulation of oil in the shell to run to the drip point beneath the electrode, thus keeping the interior of the shell clean.

Of Interest to Farmers

BROODER.—R. S. Kasson, Keesville, N. Y. The invention is more particularly designed for embodiment in a brooder having a coal stove, though it is not limited in all its features to the use of a coal stove. Among the features of the invention is a check draft in the flue which is thermostatically controlled, thus reducing the temperature of the air in the brooder instead of being solely dependent on the cooling of the stove, a non-variable draft inlet of predetermined limited capacity is provided at the base of the stove beneath the grate, the draft inlet being in free communication with the interior of the hover.

HOG WATERER.—F. H. Page, Waverly, Iowa. An object of the invention is to provide a hog waterer in which a water tank is removably supported within an outer casing and spaced from the latter whereby to afford a measure of protection to the water against extreme heat or cold by reason of the intervening air space and also by reason of the outer casing affording access for the entrance and removal of a lamp for heating the space when weather conditions make it desirable.

Of General Interest

ASH-PAN.—J. Klucina, 1532 So. 57th, Court Cicero, Ill. The invention relates particularly to ash pans for disposition within the ashpits of cook and other stoves, the object being to provide an ash pan which may be readily handled, and by means of which the ashes may be disposed of in a sanitary convenient manner, and any good coals within the ashes saved.

SHOE HANGER.—Bertha Clark, 342 50th St., Brooklyn, N. Y. The object of the invention is to provide a shoe hanger more especially designed for home use and adapted to be mounted in closets or other places to compactly support a pair of shoes, slippers or similar footwear. Another object is to hold the toe portions of the shoes in stretched condition thus maintaining the shape of the footwear and preventing cracking of the uppers.

EYES FOR DOLLS.—D. Pudlin, care of Pioneer Novelty Mfg. Co., 929 E. 25th St., New York, N. Y. A specific object of this invention is the provison of a metallic connecting piece between the eyes which is capable of being bent to properly adjust the eyes with respect to the inequalities of the eye sockets in different sized doll's heads, the connecting piece being in the form of coacting metal stampings of durable form and so designed that the eyes can be readily and quickly adjusted to obtain their proper set.

PROCESS OF PRODUCING DEHYDRATED MINERAL SALTS.—L. Doonan, Bend, Oregon. An object of the invention is to provide a process for extracting the moisture from salts, more particularly for extracting the water of crystallization from such salts as sodium carbonate. A further object is to provide a process which is continuous, that is to say one in which the material may be constantly fed in at one end of the apparatus and delivered at the other end in a water-free or anhydrous condition.

INSECT-CATCHER.—B. R. Jolly, 51 Maiden Lane, New York, N. Y. An object of this invention is to provide a spring operated suction device by means of which a fly or other insect may be drawn forcibly into a receiver or cage. A further object of the invention is to provide a device having a tube which may be suddenly projected forwardly so as to scoop up the insect while at the same time, a current of air sweeps the insect into the receiver or cage.

ALLOY.—F. Milliken, 55 John St., New York, N. Y. This alloy is characterized by its resisting qualities at high temperature, which renders it more suitable for molds for molten glass. It is further characterized by the ease with which it can be machined and therefore it renders the formation of the molds comparatively inexpensive. The alloy contains the following metals in substantially the following proportions: Copper 56-64 per cent, Nickel 13-17 per cent, Zinc 10-15 per cent, and Iron 10-15 per cent.

METER YOKE AND BOX.—L. McNutt, Brazil, Ind. This invention relates to a yoke for maintaining a tight joint between a meter and the leads to the meter. The invention also relates to a meter box open at its lower end so that the heat of the earth prevents the freezing of the meter. An object is to provide a yoke whereby the meter can be quickly and securely connected to the leads, to present the meter in a box so that it may be easily read, and its position is such that it is not in danger of getting frozen.

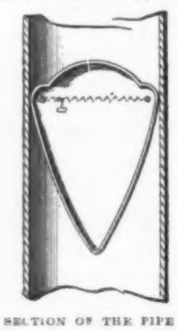
FOLDING SWING CHAIR.—A. F. Bailly, 35 N. Olden Ave., Trenton, N. J. This invention relates particularly to a folding chair or cot adapted to be adjusted for use in either sitting, reclining or any intermediate state, being adapted to be folded into very small space for storage purposes and one which is designed with means

PERSPECTIVE VIEW OF THE INVENTION ADJUSTED FOR USE AS A SWINGING CHAIR.

for causing the swinging thereof by a simple and convenient foot manipulation independent, however, of the floor or other stationary object.

Heating and Lighting

DAMPER FOR STOVEPIPES.—J. Hutchinson and C. C. Hamilton, Box 80, Gull Lake, Saskatchewan, Canada. The object of this invention is to provide a stove pipe damper which will vary the capacity of the pipe in accordance with the draft through the pipe, and which is automatically controlled by the draft. The



A VERTICAL SECTION OF THE PIPE WITH DAMPER IN ELEVATION

heart or shield shape of the damper and its concave form permit the draft to continue in the same direction, while being gradually checked, and not sharply as with a plain circular disk, even when fully checked the smoke and gas will not pour out of the stove door.

Machines and Mechanical Devices

ATTACHMENT FOR HAT STAMPING MACHINES.—N. Fromm and A. J. Thwaites, address Am. Hat Co. 10 Broadway, New York, N. Y. An object of the invention is to provide a construction wherein one operator may hold the cloth fabric or other material in place while the crown or brim is being stamped or pressed into shape. Another object is the provision of an attachment arranged with gripping members for gripping one edge of a piece of cloth or other material for holding the same in place while the operator smooths and stretches the cloth preparatory to the pressing action.

FLOOR SCRUBBING AND MOPPING MACHINE.—E. T. and F. M. Rogers, Naples, N. Y. The invention relates to floor cleaning machines of that type including a rotary scrubbing brush and a mop operative behind the brush to take up the soapy water and dirt from the floor as the machine is run over the floor. An additional object is the employment of a sprinkling device for sprinkling soapy water just in advance of the scrubbing brush and also to the dirty portion of the mop to insure the cleaning thereof the sprinkling device being controlled by means operable from the handle of the machine.

Prime Movers and Their Accessories

CARBURETER-SUPPORT.—W. G. Smith, 29 Morsemere Ave., Yonkers, N. Y. The invention relates to internal combustion engines, notably motor boats, aeroplanes, and the like, its object is to provide a carbureter support arranged to maintain the carbureter at all times right side up, irrespective of the position the engine assumes on the tilting or rocking of the aeroplane, motor boat or other vehicle on which it is used. Another object is to insure proper delivery of the explosive mixture to the manifold of the internal combustion engine.

ROTARY ENGINE.—M. DeCampo, Capuchirias 94, Mexico, Mexico. Among the principal objects of the invention are, to increase the horse-power efficiency, to prevent leakage of the power medium past to rotor, to simplify and reduce the cost of construction. The engine is so constructed that any expansive material, such as steam, compressed air, expanding gases, or other fluid may be employed as a motive power, although described in the patent as employing an expansive or power medium vitalized exteriorly to the cylinder.

Pertaining to Recreation

GAME APPARATUS.—L. W. Crompton, Box 1182, Tampa, Fla. The object of this invention is to provide a game apparatus with which may be played an interesting and instructive game, a great variety of plays being possible which permit of many formations for offensive and defensive campaigns. The apparatus consists of a board divided into a plurality of squares by lines on the board, the squares at opposite corners indicating capitals or goals, each other square being divided into nine small squares. The game is arranged for two players.

Pertaining to Vehicles

SPRING SUSPENSION.—F. E. Fey, care of U. S. Steel Products Co., 4th Ave. So. and Connecticut St., Seattle, Wash. This invention relates to spring suspension means for automobiles and other vehicles, and more particularly relates to that type of suspension means involving a system of side springs between the front and the rear axles. An object is to maximize the flexibility of the axle movement without disturbing the equilibrium of the frame and body to an appreciable degree.

AUTOMOBILE OR TIRE THEFT ALARM.—D. T. and C. C. Keenan, 1316 Callowhill St., Philadelphia, Pa. This invention is especially adapted for use in connection with automobiles so as to indicate the theft of an automobile or the spare tire, tools from the tool box, or any other part of the equipment. The general objects are to provide an electrical or automatic device, so designed that the alarm will be a continuous one when a theft is attempted so as to reveal the fact to the public or police authorities.

TIRE.—H. H. Schramm, 28 W. 48th St., New York, N. Y. This invention relates to vehicle wheels provided with pneumatic cushions, its object is to provide a tire arranged to render the tire puncture-proof. Another object is to provide the desired cushioning effect and to permit of conveniently assembling or disassembling the parts of the tire. An object is to provide a protecting member which will keep the pneumatic cushion at a distance remote from the surface of the road, so that nails and similar articles are not liable to injure the pneumatic cushion.

Designs

DESIGN FOR A HAND-BAG FRAME.—L. Jacobs, 481 Washington St., Newark, N. J. This invention has obtained patents on three ornamental designs for hand bag frames.

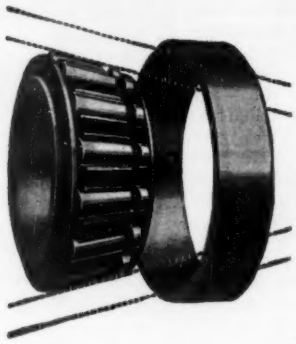
DESIGN FOR A BAG-FRAME.—W. T. Goldsmith, 481 Washington St., Newark, N. J.

DESIGN FOR A HAND-BAG FRAME.—J. Scalabrino, 481 Washington St., Newark, N. J.

DESIGN FOR A BUTTON.—B. Veit, care of Hudson Mfg. Co., 14 Maiden Lane, New York, N. Y.

DESIGNS FOR AN ARTICLE OF MANUFACTURE.—M. Oestreicher, 129 Ave. C., New York, N. Y.

TIMKEN TAPER



You can always recognize a Timken Bearing by its taper—tapered rollers revolving about a tapered "cone," within a tapered cup. To the taper is due two things that have given Timken Bearings their supremacy in passenger car, truck and tractor:

1. Resistance to wear — because a tapered roller bearing resists end-thrust, the sidewise pressure of the vehicle's weight as it rounds a curve just as well as it does the steady downward pressure caused by gravity.

2. Take-up for wear—because when the surfaces of cup, cone and rollers become slightly worn, a part turn of an adjusting nut brings them together again and the bearing is as good as new.

plus Timken Temperature Control

Everybody in the automobile industry knows that heat plays an important part in the making of steel as hard and tough as that required for Timken Bearings.

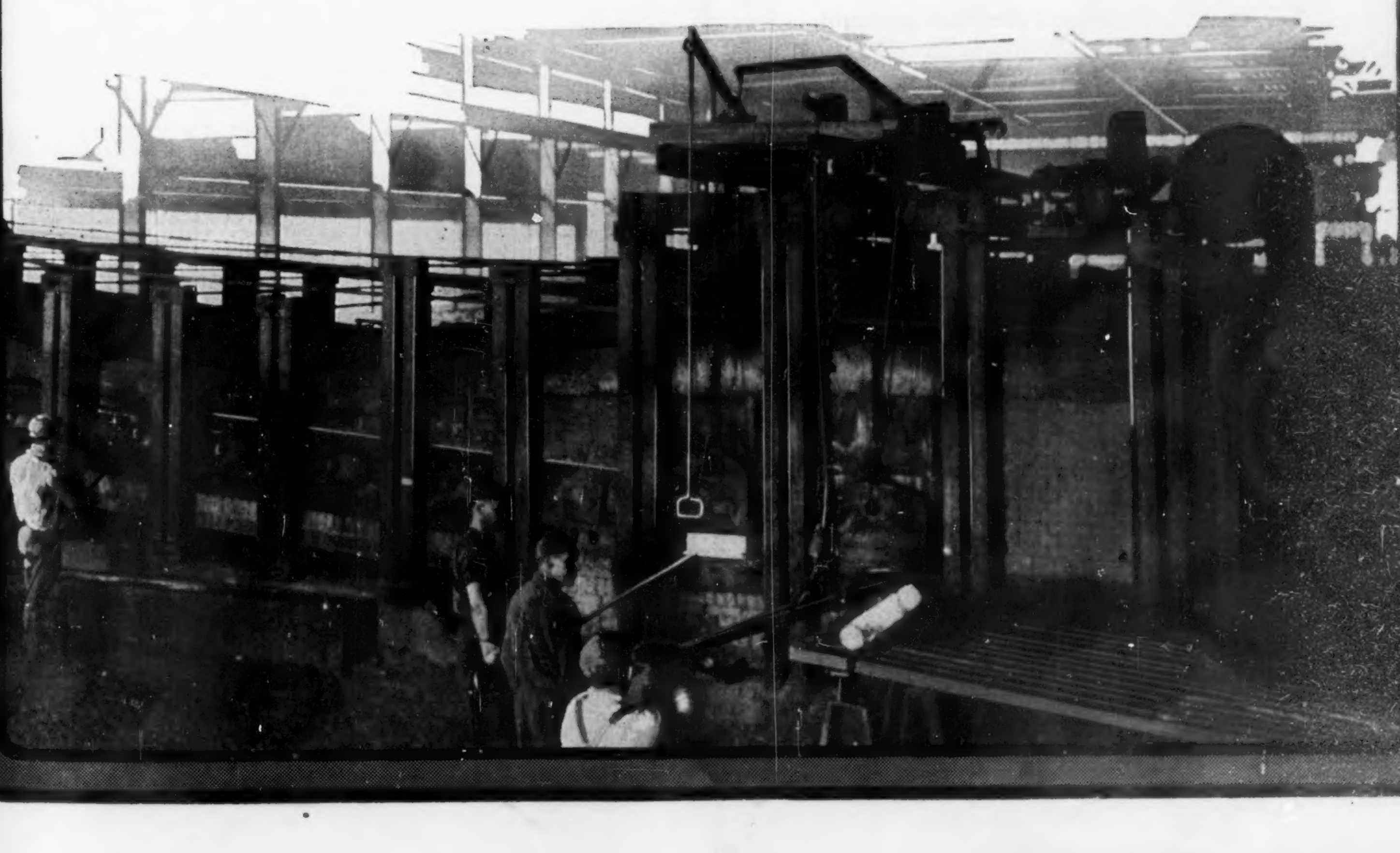
But, while everbody knows that bearing parts are carefully hardened or "heat-treated" after machining, few people realize how many times the steel has already been subjected to intense heat, how rigidly those temperatures must be controlled, and how they affect the quality of the product.

In his trip from process to process the visitor sees the application of heat in the great Heroult furnaces, in the soaking pits, reheating furnaces, annealing ovens and finally in carbonizing and hardening.

Time after time he sees the element of heat playing a part in making the steel of Timken Bearings harder, tougher, finer, more uniform, and better suited to resist the destructive forces that are always present at points of hard service in motor car, truck or tractor.

That the ability of Timken Bearings to serve so long and so well, and to protect other parts against the effects of wear depends in no small measure on the exactness of Timken temperature control, is a point too important to be overlooked by anyone who has to purchase or specify bearings for any car, truck or tractor.

THE TIMKEN ROLLER BEARING COMPANY
Canton, Ohio



The James Watt Centenary

(*Continued from page 206*)

radical. Watt introduced an independent or vacuum chamber for the condensation of the steam, removing the water jet from the cylinder, with a pump to discharge the condensed water, and devised the steam jacket to prevent the escape of heat from the cylinder. Although models of the improved engine were built in 1765, Watt's resources were exhausted and he was forced to turn to surveying and general engineering, a practical knowledge of which he had acquired while making mathematical instruments. In civil engineering Watt's most notable work was in connection with harbor development and canals.

Watt returned to his engine in 1767 and an improved model was finished in 1769, in which year he received his patent which changed for all time the atmospheric engine of Newcomen into the modern steam engine. While this patent was epoch-making, yet Watt had his business and other difficulties, so that it was many years before his steam engine was established on a permanent commercial basis. In 1769 Watt first met Matthew Boulton with whom he shortly established relations that became more intimate until by 1775 a partnership had been formed for the manufacture of steam engines. To Boulton, a broad-minded and sagacious manufacturer, business man and capitalist, the successful development of the manufacture of the steam engine was in large measure due, and the firm of Boulton & Watt later supplied not only all of Britain, but many colonies and foreign countries, not the least important of their production being the engines for Robert Fulton's "Clermont."

The engine patent of 1769 was renewed for a period of 24 years by Act of Parliament in 1775, thus insuring the establishment as a commercial type of Watt's new colliery engine with external condenser, cover over the cylinder to exclude atmospheric air and later permitting steam to act on both sides of the piston, stuffing box, and improved systems of valves. This engine soon found extensive use in Cornwall.

In 1778 the familiar copying press for letters in both roller and screw types was invented and patented in 1780. In the latter year Watt showed the fertility of his genius by suggesting for the power propulsion of boats on the Scotch canals a "spiral oar," illustrating the idea by a sketch showing unmistakably the modern screw propeller.

The steam engine Watt now saw as a source of power for mills where water or animal power was universally employed; it was in fact from the latter circumstance that he took as the unit of power for his engine, the power of a draught horse to raise a certain weight, thus establishing the now universal horsepower. Accordingly, to obtain rotary motion from the reciprocating movement of the piston became Watt's task; and manufacturing England, ready for such a machine, eagerly awaited the outcome of his efforts. In 1781 Boulton wrote to Watt, "The people in London, Manchester, and Birmingham are steam-mill mad." The rotary engine patented in 1781 met this demand, and immediately there followed that most important and practical discovery of the power of steam to act expansively, that is cutting off from the boiler after the cylinder had been filled and depending upon its power of expansion to accomplish work. The patent of 1782 gave the reciprocating expansion engine with a working stroke in both directions, and marks the genesis of the modern steam engine, both Watt's model and his full-size engine of this time showing a thoroughly good rotative mill engine, though not using any very great steam pressure. In the course of this work Watt developed the indicator which he used essentially as employed today.

LEGAL NOTICES

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The steam engine patent of 1782 was followed in 1784 by a patent with numerous comprehensive claims including such adjuncts as the poppet valve with bevelled seat and various applications of the steam engine to driving rolling mills and power hammers, as well as to "wheel carriages for removing persons or goods, or other matters from place to place." The steam hammer first proposed in 1777 was developed on a practical basis by 1783, one being constructed weighing 7½ hundredweight and striking 300 blows a minute with a drop of 2 feet. Watt also developed, if he did not actually invent, the familiar centrifugal ball governor for the steam engine, while the mercury steam gage for the boiler and the ingenious parallel motion connecting piston and beam, later developed into crosshead and guides of permanent practice, were entirely his own inventions.

In chemistry Watt was one of the discoverers of the composition of water and was in constant communication with leading French and British chemists. In 1783 he advocated an international decimal system of weights and measures. Among his last inventions was the "eidograph," a mechanical device for copying sculpture. While he enjoyed many foreign honors as well as high distinction in his own country, Watt was essentially a democrat, and shortly before his death declined a well merited baronetcy.

It is indeed difficult to summarize a life so replete with accomplishment, but unquestionably as one biographer, himself an engineer, remarks, James Watt rendered the steam engine more compact, more powerful, and at the same time more regular and positive in its action, and thus made possible its use in steam navigation and its adaptation to the locomotive as well as to productive industry. Appreciating the full suggestiveness and implication of this apparent understatement of James Watt's relation to mechanical science and industry, it is not hard to realize the vast value and comprehensive nature of his work on which an undying fame rests.

Novel Means for Repairing a Worn-Out Pump

(*Continued from page 207*)

to above. Furthermore, the cost of materials and labor is much greater today than in 1912. When such factors as loss of profits, overhead expenses, non-productive labor and contract penalties are taken into consideration, obviously every week of idleness meant a loss of thousands of dollars.

The pump chamber of the sand sucker illustrated is 14 feet in outside diameter, and consists of two massive steel castings having a total weight of 7 tons. The abrasion had been so severe it was necessary to rebuild both side walls of the pump chamber for a distance of 8 inches from the inner circumference. The thickness of the added metal varied from 1½ to 2½ inches. In addition, a new section approximately 14 by 18 inches in area had to be welded into the throat of the casting. The latter was approximately 3½ inches in thickness.

In order to insure holding the two halves of the chamber in alinement during preheating and welding they were bolted together and the heavy outer reinforced sections of the castings were not heated, as this would have produced internal strains, either breaking the castings or shearing the bolts that held them together. Preheating by means of charcoal was applied locally for a distance of about 14 inches in from the edges of the flanges, each preheat extending for a distance of 3 feet around the inner circumference.

The total weight of steel added to the castings by welding amounted to 1,264 pounds. The operators worked in pairs. As the heat in the small enclosure where the men worked was intense, it was neces-

sary to hold several welders in reserve and to work on the relay plan, each welding shift extending for a period of twenty minutes. Six days were required to complete the building-up work.

As the built-up surface will be subjected to the same abrasive action of sand and gravel, high carbon steel welding rods were used for the purpose of building up, thereby giving an extremely hard surface, in fact, one that it was impossible to cut with a file after cooling.

The Atlantic Fleet and the Panama Canal

(Continued from page 209)

the Panama Canal on its way to its new duties, consists of four divisions and includes 14 battleships. Of these six are predreadnoughts and eight are dreadnoughts. The Divisions are as follows:

Pacific Fleet; Flagship New Mexico.

Predreadnought	Virginia	Div. I
"	New Jersey	
"	Rhode Island	
Predreadnought	Georgia	Div. II
"	Nebraska	
"	Vermont	
Dreadnought	Wyoming	Div. VI
"	Arkansas	
"	New York	
"	Texas	
Dreadnought	New Mexico	Div. VIII
"	Tennessee	
"	Idaho	
"	Mississippi	

These vessels form the backbone of the fleet; with them, of course, is associated a big fleet of destroyers, submarines, supply and fuel ships and the various other types of vessels that go to make up a well-found modern fleet.

Desert Plants as Fodder

A FEW months ago when cattle were starving by the thousands on the drouth stricken range of Texas, New Mexico and Arizona, the cattlemen looked helplessly upon vast quantities of green vegetation—sotol, bear grass and Spanish bayonet—desert plants that in their rough state were unfit for stock feed. It remained for an ingenious machinist to invent and construct a shredding machine that reduced the tough desert growth to sustaing feed for the perishing cattle. From the ranchmen who were interviewed it has been estimated that more than 16,000 head of cattle were fed on these shrubs, and that probably 90 per cent of this number would have died had not the inventive genius of man come to the rescue and converted this otherwise useless material into an emergency feed.

Electric Properties of Silicon and Germanium

SILICON exhibits the highest known thermo-electric power. It is a curious fact that silicon is either strongly electro-positive with respect to copper or electro-negative, according to the method of preparation, and by combining the positive and negative varieties thus obtained, we can construct a thermo-electric couple displaying the enormous differences of potential of 1,000 microvolts per degree centigrade. The small quantities of impurities, such as iron, which are always found in silicon, diminish the thermo-electric power without, however, changing its sign. By crystallizing the silicon in aluminum to purify it, we obtain a strongly positive product; by crystallizing it in silver or in tin, in each of which it is less soluble, we arrive eventually at an electro-negative product.

Experiments with Germanium demonstrate that this body presents the highest thermo-electric power next to silicon. These two substances also resemble each other in other respects, in particular, in their remarkable power of rectification with respect to the Hertzian oscillations.

Recent Patent Decisions

This case involves what is commonly known as "tree doctoring" by filling up the cavities of decaying trees. The care of trees is a matter of such general importance, and one of the patents involved is of so broad and inclusive a character, that if the inventor has benefitted the art in the way he claims, he is entitled to a broad claim to cover his invention. On the other hand, if his invention is not of that character, the public should not be precluded from doing everything it can to preserve trees.

The only holding in this case is one of procedure. In a suit for the infringement, the question of the validity of the patent cannot be reviewed on plaintiff's appeal, where there are two patents in question and one was found infringed, and relief was denied the other.—*Davey Tree Expert Co. v. Van Billiard. U. S. C. C. of Pa.*

Suit by A. G. Spalding & Bros. against John Wanamaker, New York, and against the successors of Samuel Buckley & Co. on London and New York, for infringement of patent. Decrees for the defendant in each suit, and plaintiffs appeal.

These are appeals from decrees of the District Court for the Southern District of New York, dismissing the bills with costs.

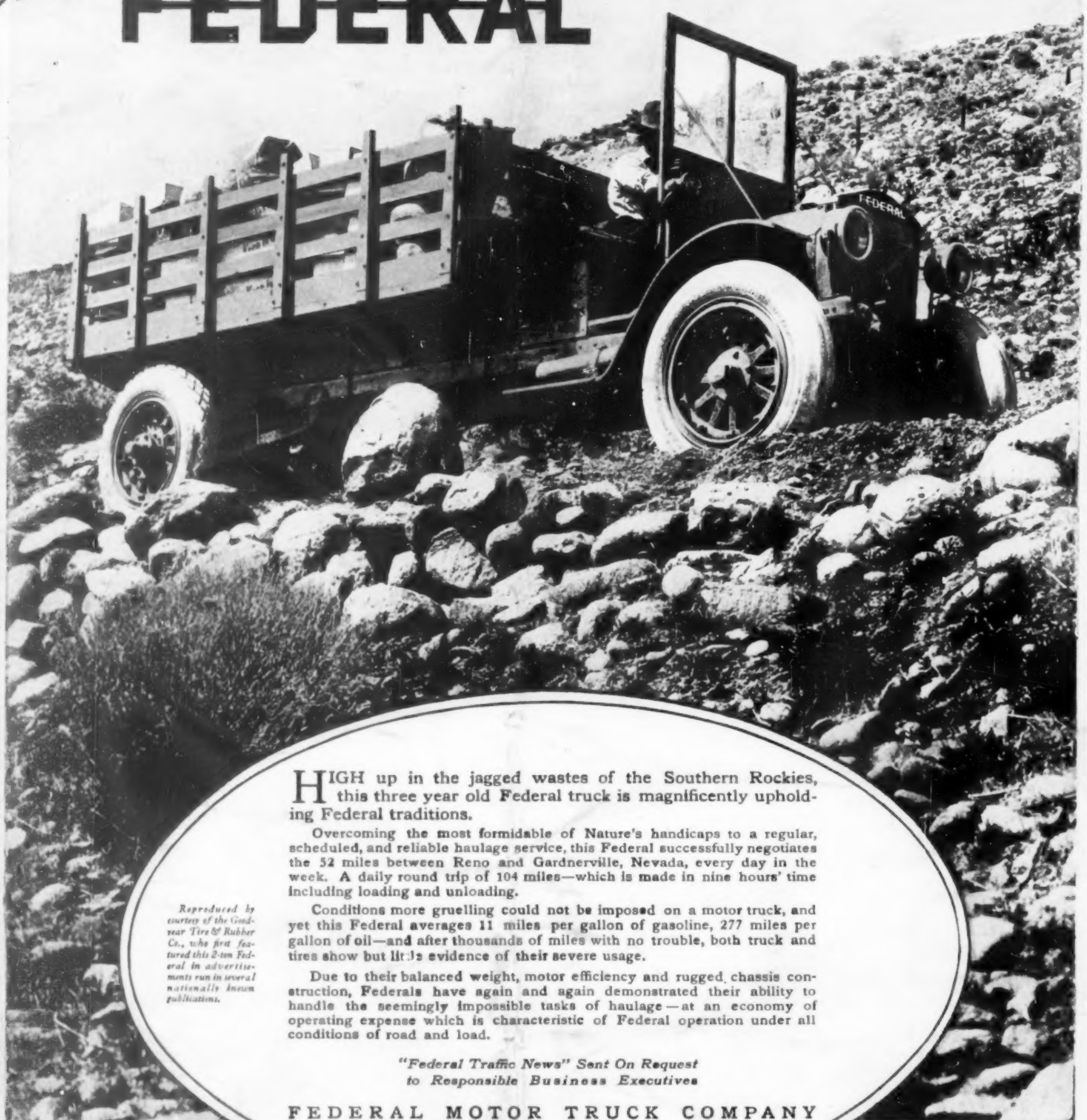
The patent recites that the invention relates to golf balls, and has for its principal object to improve the flight of the ball by giving it "a sustained hanging flight" with "a flat trajectory with a slight rising tendency particularly towards the end of the flight." It acknowledges that in the past it was common to mark the surface of golf balls with grooves of even width, intersecting each other and leaving between them isolated polygonal portions; that another common marking consisted of separate prominences upon the surface, resembling the surface of a blackberry, and named for this reason the "bramble" pattern. The patent then proceeds as follows:

"The character of the marking which constitutes the present invention may be described in general terms as an inverted bramble pattern, and consists of isolated cavities the essential features of which are that they must be substantially circular in plan and substantially evenly distributed. They must be shallow, and their sides, particularly at the lip of the cavity, must be steep. Steepness of the cavity walls is essential to the hanging flight, but excessive depth besides promoting the collection of dirt, is detrimental to length of flight by offering great resistance to the passage of the air. Consequently the cavity must be shallow and the steepness of its walls confined to the immediate neighborhood of the lip."

The defendants made balls pitted with spherical cavities similar in proportion and size to the plaintiff's. The issue in the case was whether these conformed to the words "with steep sides at the peripheries only of said cavities," which are contained in all the claims in suit. The section of the defendant's pits was the arc of a circle, and the angle subtended varied between 28 degrees for the defendant Wanamaker's ball, and 35 degrees for the defendant Buckley's. The tangents to the curve of the pit at the lip were therefore, in the first case, of 152 degrees, and, in the second, 145 degrees. The District Court found that pits of this character did not answer the element of the claims above mentioned and dismissed the bills for non-infringement.

Held, that where a claim broad enough to include defendant's article was several times rejected by the Patent Office, the patentee is thereby precluded from asserting that the claims allowed should be given the same meaning as the rejected claim. The court examines the file wrapper of a patent only to determine the question of estoppel through rejected claims, and cannot consider the arguments of the applicant and the examiner.—*A. G. Spalding & Bros. v. John Wanamaker, N. Y. Circuit Court of Appeals, N. Y.*

It's Another FEDERAL



HIGH up in the jagged wastes of the Southern Rockies, this three year old Federal truck is magnificently upholding Federal traditions.

Overcoming the most formidable of Nature's handicaps to a regular, scheduled, and reliable haulage service, this Federal successfully negotiates the 52 miles between Reno and Gardnerville, Nevada, every day in the week. A daily round trip of 104 miles—which is made in nine hours' time including loading and unloading.

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Due to their balanced weight, motor efficiency and rugged chassis construction, Federals have again and again demonstrated their ability to handle the seemingly impossible tasks of haulage—at an economy of operating expense which is characteristic of Federal operation under all conditions of road and load.

Reproduced by courtesy of the Goodyear Tire & Rubber Co., who first featured this 2-ton Federal in advertisements run in several nationally known publications.

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